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The Whale-Headed Stork.

An Ornithological Puzzle.

By W. P. PYCRAFT.

WHILE fully realizing how many are the difficulties which naturalists travelling in wild places have to contend with, one cannot but feel that opportunities of studying the habits of the more remarkable of the creatures which are encountered are commonly neglected. Little or nothing is generally recorded of the spoils of hunting save the details attendant on the killing, or of the nature of the country inhabited by the slain.

That strange, almost grotesque-looking bird, the Shoe-billed, or Whale-headed Stork, *Balæniceps rex*, affords a case in point. It is one of the ornithological puzzles of the "dark continent," a bird of quite exceptional interest, yet of its habits in a wild state we know next to nothing. The earliest known examples to reach Europe were two brought by Mr. Mansfield Parkins from the White Nile, and these were figured by the magic pencil of Joseph Wolf, and described by the celebrated John Gould, in the "Transactions of the Zoological Society for 1850" as abnormal pelicans! Ten years later two living specimens were brought home by Consul Petherick, and were purchased by the Zoological Society and deposited in the Gardens. These were the first—and I believe the last—seen alive in Europe. They were the only survivors of six shipped at Khartoum, in the neighbourhood of which they had been taken. Yet nothing of their habits seems to have been made out.

Though commonly supposed to be confined to the reedy swamps in the neighbourhood of the Bahr-al-Gazal and the Upper Nile, this is by no means the case, for Sir Harry Johnston found them by no means rare in Uganda. He found them on the Northern shores of Victoria Nyanza and at Entebbe, in marshes and narrow backwaters; only rarely on the shores of broad rivers or open pieces of water. Their food, he tells us, consists in the main of fish, but that they probably vary this diet with frogs, crustaceans, and molluscs. Further than this, save that they are solitary birds, seen only in couples, presumably male and female, he tells us nothing. Yet one very important fact could have been ascertained with the greatest possible ease and the least possible amount of watching—this is the nature of the flight. Do they fly after the fashion of Herons, with the neck drawn up close to the body. or like Storks, with the head and neck strained forward? The importance of this omission becomes manifest when it is remembered that authorities are divided in opinion as to whether this weird creature is to be regarded as a Heron or Stork. True, the affinity of a bird cannot be determined by its flight, but this particular piece of information in this particular case would have been valuable. Nor has anyone so far, I believe, ever commented on this point.

As may be gathered from the accompanying sketch (Fig. 1), the general appearance of this bird is somewhat remarkable. Clad in sober grey, and therein Heron-like, in its contemplative moods it recalls the Stork; yet it differs from both in the huge size of the beak, broad, deep, and hook-tipped. A touch of ferocity is added by the great yellow eyes, while, as if to complete this study in contrasts, a suspicion of the ludicrous is added by the queer little tuft of feathers which surmounts the head. One

THE SHOE-BILLED STORK.

Fig. 1.

feels somehow irresistibly compelled to regard it as having been designed for a showman's bird, but which, by some strange mischance, has so far eluded this unhappy fate, at any rate in so far as its race as a whole is concerned. As if, indeed, aware of its marketable value, it seems always to have shunned the haunts of man; when taken it has always been by surprise. Even in times far past it seems to have been no less cautious, and sedentary, for we may gather that it never wandered

northward far enough to encounter the old Egyptian animal painters, or surely it would have found a place in the wonderful frescoes with which they adorned the Pyramids; nor has it probably ever extended far south of its present range. It is a species, in short, which we may assume has never been numerous, and this fact naturally excites comment. What restraining influences have kept its numbers down? What agencies have fashioned the contours of that marvellous beak?

If more were known of its habits these questions might be easier to solve; as it is we can only guess. We are told that it feeds mainly on fish, varied by frogs, crustaceans, and molluscs; but this diet is apparently only surmised, and mollusca probably form but a small part of the bill of fare, if they are partaken of at all, and the same applies to the crustacean element, which must at any rate be limited to tolerably large species, such as crayfish. But no crayfish is known to occur in the whole continent of Africa. But perchance the haunts of this bird harbour some unknown relative thereof. Fish and frogs then, and possibly small mammalia, form the staple diet of this ornithological puzzle. And if this hazard is correct, the bill of fare differs not from that of the typical Herons and Storks. Why then has the Boat-bill developed so strange a beak to effect their capture? Since the Storks and Herons enjoy a world-wide distribution, and are represented by numerous species, it would seem that the Boat-bill has been hampered in the struggle for existence by its eccentricity. The fact that it is non-migratory, taken in conjunction with the fashion of the beak, seems to suggest that it feeds upon a particular kind of fish not readily captured with the typical Stork-like beak, or that the conditions of capture must be peculiar, and having, as it were, laid down plant for the pursuit of this peculiar fishery, it became impossible to carry on business elsewhere. Thus, if, and when, at any time this population of fishers increased beyond the resources of food supply, famine and death, in place of migration, had to relieve the pressure. And thus the initial structural peculiarities which gave the ancestral Boat-bills an advantage over less modified Storks were gradually intensified. Or, to put it another way, the inherent tendency of some primitive members of the Stork family to develop boat-shaped bills proving advantageous in this particular region of Africa, that tendency had free scope for its development, but in proportion as it conferred advantages in this particular region, so in inverse proportion this modification unfitted it for life elsewhere.

A glance at the skull of this remarkable bird will show that the transformation of the beak has been accompanied by very pronounced though less striking changes in other parts of the skull, notably in the palatal bones; and to measure the nature and extent of these changes a comparison must be made between this and the skull of a typical Stork (Fig. 2), though, doubtless, this also has departed more or less markedly from the plan of the skull of the ancestor common to both. From the palatal view of the skull the most striking features of this change, in the Boat-bill, are seen in the great shortening and widening of the palatines, and the changed position of the pterygoid condyle of the quadrate which runs parallel with the long axis of the pterygoid, and in the same level therewith. In the Stork this condyle is at a much lower level, and at nearly right angles thereto. In the Stork the two mandibular articular condyles of the quadrate run nearly parallel one with another, in the Boat-bill the anterior, pterygoid, condyle has its long axis at right angles to the posterior, or quadrato-jugal, condyle. Furthermore, the pterygoid condyle in the Boat-bill is a trochlear condyle, and fits into a deep groove in the lower jaw, in a way met with in no other birds; and this again suggests some peculiar requirements for the capture of food. The palatal portion of this strange beak, it will be noticed, is not cleft as in the Stork. In side view this beak is also peculiar, and more particularly so in the fact that the lachrymo-nasal fossa, the space between the beak and the lachrymal, is entirely closed by the backward growth of the bony tissue of the great beak, a condition rare among birds. The top view of the skull (Fig. 3) shows that this ponderous beak joins the skull by means of a hinge running across the skull just behind the lachrymal. This hinge seems to be inseparably associated with large beaks, and is due to mechanical factors rather than to any special requirements in the nature of the food. It is met with in quite a number of birds.

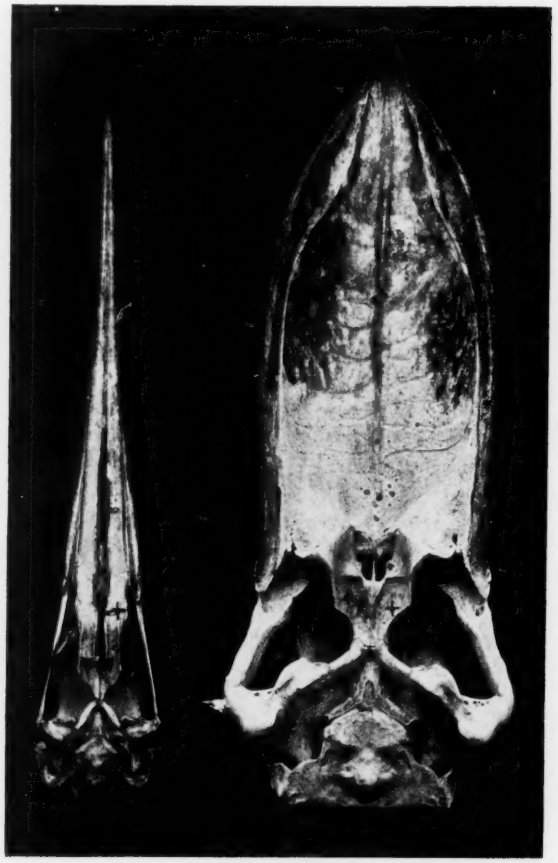

Fig. 2.—Undersurface of the skull of Balæniceps rex (right hand and of a common Stork (left hand). Compare the form of the palatine bones—marked +—and beak.

We have suggested that this remarkable beak may have had its origin in some inherent, blastogenetic variation, which was fostered, as it were, because useful. In other words, the beak of this bird appears to support the theory of *orthogenesis*; that is to say, of predetermined evolution, allowed to run on unchecked, or only slightly checked, by the requirements of the environment. This may, indeed, be true. On the other hand, the more usual explanation would be to regard this beak as the outcome of a long process of selection, whereby all individuals were eliminated whose beaks tended to develop along more normal lines. But it seems difficult to imagine that the minute variations in the direction of

the characteristic beak of the Shoe-bill could have been of sufficient importance to give any advantage to the birds so varying over their competitors ; for the physical conditions were, at the commencement of this development, much the same as now, if not identical. Thus if the highly specialized beak of the existing Shoe-bill represents the minimum standard of development, the earlier, incipient stages could never have been sufficient to enable their possessors to live.

But whichever interpretation is adopted, it is a remarkable fact that similar beaks have been developed by birds both nearly and remotely related, and in most cases from beaks of the dagger-like type.

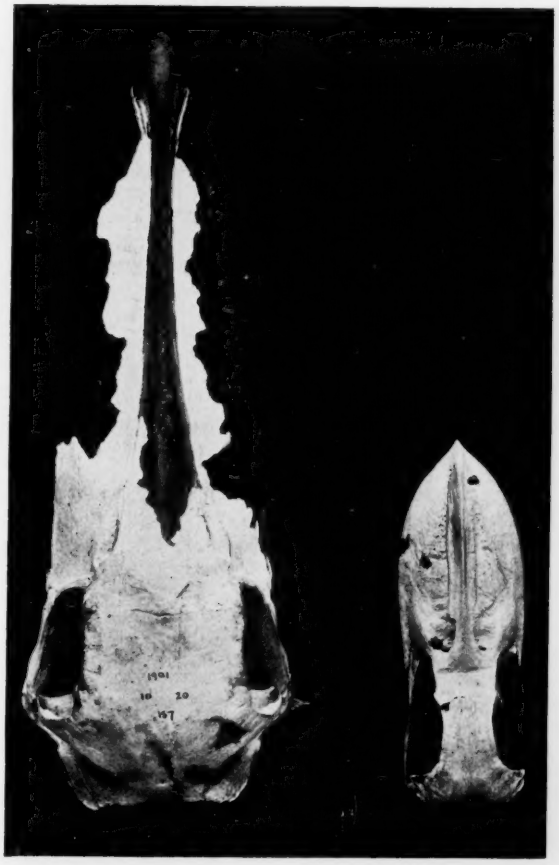

Fig. 3.—Top view of skull of Balæniceps and Boat-bill.

Take for instance the beak of the Boat-bill (*Cancroma*), a small species of Night Heron found in tropical America. The beak of the bird is, as may be seen in Fig. 3, strangely like that of the Shoe-bill, and may perhaps be an instance of parallel development. But besides this one of the Kingfishers—the Shoe-billed Kingfisher of New Guinea (*Clytocex rex*)—has also developed, from a similarly dagger-like bill, a beak very like that of the two Herons herein described. But while the great Shoe-bill (*Balæniceps*) and the Boat-bill (*Cancroma*) are fishers, the Kingfisher is an eater of beetles and other insects! So that it would seem, then, that there is not so close a relation between the shape of the beak and the nature of the food as some would have us believe; and this lends colour to the orthogenetic interpretation, which, it must not be forgotten, is also governed by natural selection.

And now a word as to the possible ancestry of the *Balæniceps*. In its general coloration, in the lanceolate breast-plumes, in the great length of the toes, the position of the hind toe, the presence of powder-down patches, and the coloration of the eyes, *Balæniceps* agrees with the Herons. And a similar agreement obtains in regard to the syrinx, and some other internal characters. On the other hand, in the pose of its body when at rest (Fig. 1), and osteologically, *Balæniceps* is an undoubted Stork. Every detail of the skull proclaims it; the limbs, shoulder, and pelvic girdle tell the same tale. And this is especially true of the sternum. Apart from the sternum itself, and the form of the coracoids, the furcula, or merry-thought, in the Storks, articulates with the keel of the breast bone; in *Balæniceps* this mode of attachment has gone a step further, the merry-thought fusing with the keel. This is somewhat remarkable, because this form of attachment is generally associated with strong powers of flight and diving habits; in neither of which forms of activity is the Shoe-billed Stork supposed to excel. It is hardly likely indeed that it will be found to possess diving powers. What its aerial movements may be appears to be unknown, but a careful study of its habits may show that, like the Pelicans, it may resort to the upper air for exercise.

In many particulars *Balæniceps* stands alone, and one of these differences, though a comparatively small one, is the pose of the head when at rest. This is due to the articulation of the skull with the vertebral column, the vertebræ having their articular facets so placed that the neck, where it joins the head, has a peculiar ⅂-shaped kink, and thus it is that the beak, while the bird is at rest, is always held resting against the neck.

The Shoe-billed Stork, then, it would seem, is to be regarded as an extremely ancient member of the Stork family, standing somewhere near the parting of the ways between the Storks and the Herons, and hence partaking of the characters of both. But the Herons are to be regarded as a side branch of the Storks, rather than the reverse.

A Beaver Dam.

MR. R. B. MARSTON, of the *Fishing Gazette*, has been kind enough to send us a photograph of a Beaver Dam which exists near Florissant, in Colorado, U.S.A. Florissant is perhaps best known for the remarkable

geological strata in its neighbourhood, in which, by the presumed overwhelming of a small lake by a lava-flow during Tertiary times, many contemporary insects were wonderfully preserved. The photograph was taken by Mr. S. Howarth, and the dam exists at a height of 8000 feet.

Messier.

By J. E. GORE, F.R.A.S., M.R.I.A.

CONSIDERABLE interest has been aroused in the subject of comets by the recent "daylight comet," and the approaching display of Halley's comet; and some account of the French astronomer Messier, the famous discoverer and observer of comets, may prove of interest to the reader.

Charles Messier, who was called by Louis XV. "the comet ferret," was born at Badouviller, in Lorraine, on June 26, 1730. He was the tenth of twelve children. Before he reached the age of eleven he had the misfortune to lose his father. While still a boy, Messier had the opportunity of seeing the comet of 1744, which was remarkable for displaying a number of tails. He also observed the great eclipse of the Sun which took place in 1748. This eclipse decided his career in favour of astronomy. In the year 1751, at the age of 21, he went to Paris possessing little or no recommendation, except a good handwriting and some skill in drawing. The famous astronomer, Delisle engaged him to keep the register of his observations, and at first employed him in copying a map of the Great Wall of China, and a plan of the City of Paris!

Messier tells us in his Memoirs that from the end of 1753 he had become very experienced in his search for comets, a work which suited him best and to which, in fact, he practically devoted himself all his life. His curiosity about astronomical phenomena at this time was limited to viewing them merely as interesting spectacles; noting the time of their appearance and other circumstances connected with them, without the ambition of qualifying himself to calculate and predict their occurrence.

Messier worked for some time with La Grive on a plan of Paris and a map of France. On Delisle's return from a journey in Russia, he brought home with him a collection of books, manuscripts, and astronomical and geographical observations. These he presented to the Naval Office of Charts. The astronomical portion was afterwards sent to the Paris Observatory. On account of this presentation, Delisle was appointed Naval Astronomer, and obtained for Messier the post of clerk of the office with a salary of £40 a year, to which Delisle added board and lodging.

Owing to an announcement from Berlin, Messier followed the comet of 1758 from August 15 to November 2 of that year. He also observed the famous comet of 1759 (Halley's), the return of which Halley had predicted for that year. As at present, all the astronomers of that day were anxious to see the comet at the earliest opportunity in order to improve the orbit, which brought it back at intervals of 75 or 76 years. The calculations connected with its return gave the famous Clairaut an immense amount of labour. These calculations showed that the comet's arrival at perihelion would be retarded by the disturbing action of the planets Jupiter and Saturn, and he fixed the date of the perihelion passage for April 13, 1759, with a possible error of 19 days. In those days these computations were novel, and Delisle took the trouble to draw a map showing the different paths which the comet would follow in the sky according to the date of the perihelion passage. Other astronomers, including the famous La Caille, were occupied with other matters, and thought it rather waste of time to watch for a comet which might possibly not return at all. Messier, however, acting under instructions from Delisle, kept a careful watch, and for nearly 18 months searched without success in positions which afterwards proved to be incorrect. He might have been more fortunate had he been left a free hand in his observations, for the comet was first seen in Saxony on Christmas Day, 1758, by an amateur astronomer named Palitzch. Some days later it was noticed by a doctor named Hoffman, and on January 18, 1759, it was again discovered by a Professor at Leipsic, who recognised it as the expected comet and computed its motion.

None of these observations, however, became known in France for several weeks, and it was only on January 21, 1759, that Messier at last saw the comet. He kept secret his rather tardy discovery, and saying nothing about it to anyone except Delisle he followed the comet till February 14, when it became lost in the sun's rays. At last Mayer informed La Caille and Delisle of the comet's return; and Delisle, seeing that the secret could not be kept much longer, allowed Messier to speak of his observations, and to tell the secret to the other astronomers. This tardy information was not, however, well received by them, and they rejected the assistance given with such bad grace, and not with the authority they thought necessary in such a new and important research. They were not satisfied with Messier's observations and looked forward with emulation to observing the comet themselves after it had emerged from the sun's rays in the beginning of April. Delisle, however, acted in the same way with reference to another comet discovered by Messier on January 21, 1760. This conduct seems to be unintelligible, as Delisle did not calculate any orbit and deserved no credit for observations which he took exclusive possession of. This was very different from other astronomers, who, fearing that bad weather would interfere with satisfactory observations to enable them to compute a good orbit, hastened to announce publicly discoveries of this kind.

About this time, Delisle having given up science and the Chair of Astronomy at the Royal College to enable him to devote himself entirely to religious work, Messier was left alone to his own devices, and occupied himself with his favourite researches with greater zeal and success. During 15 years almost all the comets which were discovered were found by him. In fact he spent his life in discovering comets, and the maps which he drew of their paths were considered very accurate. The height of his ambition was to become a member of the St. Petersburg Academy. He was a man with the simplicity of a child. A story is told of him that when his wife died the care which he bestowed on her during her last illness was the cause of his missing the discovery of a comet which Montaigne had found. The loss of this comet weighed upon his mind, and when some friends condoled with him on the loss of his wife he said, "Alas! I had discovered twelve comets and this Montaigne has robbed me of the thirteenth!" And he wept; then remembering that it was his wife he should weep for, he said, "Ah, that poor woman!" and continued weeping—for his lost comet!

He sent one of his comet maps to the King of Prussia, who at once requested the Berlin Academy to elect him as a member. He was also elected a member of the Academy of St. Petersburg.

As his reputation increased, so did his very moderate income. His title of "Clerk" was altered to that of Naval Astronomer. Each of his cometary discoveries procured his election to a foreign academy. He was several times proposed for the French Academy; but for a long time without success. He was reproached for being too exclusively addicted to observations to the neglect of calculation and theory. They might have made the same objection to the famous Tycho Brahe!

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He was less severely judged by the rest of Europe, and after the death of La Caille he was universally regarded as the leading astronomer of France. Gradually, however, the Paris Academicians became reconciled to the idea of admitting a mere observer to their august body, and he was at last elected in 1770.

It must be admitted that Messier did all he could with the means at his disposal. With merely good eyesight, an excellent small telescope, a pendulum, and a quadrant, what more could be expected of him but observations of comets, eclipses, and other celestial phenomena? All his discoveries of comets were made with a 2-foot telescope of only $2\frac{1}{4}$-inch aperture magnifying about 5 times, and with a field of view of 4 degrees.

Messier's comet maps did not help in the calculation of orbits. They were too rough for this purpose. Only once did Messier venture to give the elements of a comet's orbit. It was that of Halley in 1759, the orbit of which had previously been computed by La Caille, Lalande, and Maraldi. It has been found that if we take the arithmetical mean of the elements found by these three astronomers, we find very nearly the system of elements found by Messier and presented to the French Academy. This seems a curious coincidence if we consider that Messier claimed that his orbit was deduced by calculation from his own observations.

Messier was anxious to follow the planet Uranus, which was discovered by Sir William Herschel on March 13, 1781. This discovery, which was then unique in the annals of astronomy, was announced to Messier by Maskelyne, the Astronomer Royal of England. For about a year Messier zealously followed the course of the new planet, when a very serious accident happened to him which interrupted his labours for a long time, and indeed had a permanent effect on his future work. As he was walking one day, November 6, 1781, with the President of the Academy, M. Saron, in the gardens of Monceaux, he went to see a grotto which attracted his attention. An open door seemed to be the entrance to another grotto. But this was an ice-house, and, proceeding incautiously, he fell a depth of 25 feet on a heap of ice. He broke his arm and thigh, injured both his sides, and received a wound on his head which bled profusely. It was with difficulty that he was extricated, and, notwithstanding the skill of a well-known surgeon, a fellow-Academician, his recovery was tedious and the cure imperfect. Disgusted with surgery, he placed himself in the hands of Dumont, who broke his arm anew in order to set it better, and confined him to bed for several months. He received much sympathy from his friends in his misfortune. His colleagues, Saron, Boscovitch, and Sage, were especially solicitous for his recovery. Sage obtained for him a pension and a gratuity. It was not till a year after his accident that he could return to his observatory to prepare for observing the transit of Mercury, which he observed on Nov. 12, 1782. Having become an academical pensioner, he saw with dismay the suppression of the Academy in 1793 by the Revolutionary leaders. His pension ceased, and even the payment of the rent of his observatory at Cluny was discontinued. He continued, however, to reside there, and did not alter his habits. Fortunately, he could exist on his savings, as he was very economical and managed to live on his very moderate income. It appears, however, that his resources were very limited, for he could not find means for lighting the lamps which he used in his nightly observations, and on several occasions he was obliged to appeal to Lalande for some oil!

In September, 1793, he discovered a new comet in the constellation Serpentarius. The astronomers of Paris were then dispersed owing to "the reign of terror." Saron alone remained. Messier sent him his observations. From these Saron calculated an orbit; but a few days later he was arrested and executed.

Soon after this, however, Messier experienced better times. The Institute, the Bureau of Longitudes, and the Legion of Honour, to which bodies he had been elected, came to his assistance and restored with interest his financial losses, thus placing his family in comfort. On the death of his children, a niece of his, Madame Bertrand, came to live with him, and during the last 19 years of his life paid him every care and attention. He continued in good health up to the age of 82 years, and then his strength began to fail. He could only read and write with a strong magnifying glass, which much fatigued him. After some time he had an attack of paralysis followed by dropsy, and died on the night of April 11, 1817, at the good old age of 86 years.

Messier did not write any books on astronomy. He left nothing but memoirs in which he gives an account of his astronomical and meteorological observations. These are scattered through the volumes of the French Academy proceedings and those of the *Connaissance des Temps*. He made many observations on sun spots. Some of these were made at intervals of three days, which should have been sufficient to determine the period of the sun's rotation on its axis. But an examination of these records gave discordant results. This may possibly be due to "proper motion" in some of the spots he observed.

When Lalande published in 1775 a new celestial globe he named a small constellation after Messier. This was formed from some small stars scattered between the constellations Cepheus, Cassiopeia, and Camelopardalis. But in modern maps and globes this group of stars is ignored.

Messier showed on every opportunity how little respect he had for theories, and he seems to have valued nothing but practical observations. He might well have been asked, What is the use of collecting a large number of observations if we have no theory in view? When he had observed a phenomenon, and when either by an error in the tables or by the mistake of the computer he found some difference between theory and observation, he seemed to delight in pointing out the discrepancy.

In his search for comets, Messier discovered several nebulæ, and to assist in the discovery of his favourite objects he formed a catalogue of the nebulæ known in his time. In the year 1771 he published a catalogue of 68 nebulæ in the Memoirs of the French Academy. In the years 1781-1782 this list was republished in the *Connaissance des Temps*, and 35 other nebulæ were added, thus bringing the total up to 103 nebulæ. Many of the nebulæ are still known by their number in this catalogue. Thus the "Dumb-bell" nebula is Messier 27, the great nebula in Andromeda is Messier 31, and the great nebula in the "Sword of Orion" is Messier 42.

DR. W. VON OECHELHAEUSER has invented a method of converting ordinary coal gas into a very light gas which is eminently suitable for filling balloons. The process consists in decomposing and removing all of the heavy hydro-carbons and nearly all of the methane, and converting the carbon dioxide into the lighter carbon-monoxide. The resultant product is an almost odourless gas which contains more than 80 per cent. of hydrogen and has a density of 0.225. The density of ordinary coal gas is 0.41 and that of pure hydrogen is 0.067. The lifting power of the new gas is about one ounce avoirdupois per cubic foot; the buoyancy of coal gas is 0.7 ounce; and that of commercial hydrogen is 1.1 ounce per cubic foot. The balloon of the Aeronautical Society of Anhalt is to be filled with the new gas.

XUM

Migrating Stars.

By J. A. HARDCASTLE, F.R.A.S.

> Nations in course of many years put on
> A Various Face; but Heaven wears always one;
> Other than 'tis our Fathers saw it never
> Nor shall our Nephews.

THOSE lines are taken from a translation of The Sphere by Marcus Manilius, published by Edward Sherburne in 1675; and they express quaintly perhaps but clearly the great doctrine of the Fixity of the Stars. That doctrine has without question exerted a profound influence for good over the imagination of the human race, and the critic who casts it aside as merely an obsolete error only proves his own incapacity for criticism. New conceptions of the stellar universe have arisen to replace it and will doubtless in their turn elevate the responsive mind, but the new must be built on the old, or, to use a truer metaphor, the new must grow out of the old, for intellectual change is no less organic than is our physical growth. From the ancient doctrine of the incorruptibility of the heavens has sprung our own implicit acceptance of the Continuity of Nature, that is to say, the permanence of what we call the Laws of Nature. We need not fear to cast our imagination far into the future and contemplate the possibility of our present views undergoing as radical a change as has been the fate of the Fixity of the Stars, though we may not at present be able to suspect from what direction the new knowledge will come.

It requires, therefore, no defence if we start with the statement that all the stars are moving; we need not rely simply on the *a priori* inconceivability of the contrary, we have the observed fact that the angular distance between any pair of stars is not now the same as it was in the days of Bradley. Nor need we here emphasise the great difficulty of grasping the precise meaning of the words Proper Motion, but it will be obvious that any vagueness as to the technical contents of that phrase will tend to obscure our judgment when we discuss the indications of a systematic distribution of proper motions.

These indications were first brought to light by Proctor* nearly 40 years ago, and to him we owe the origin of the expression "star-drifts." He showed that large groups of stars were animated by a motion across the sky in the same direction and at the same rate, and we must admit the cogency of his argument that this cannot be regarded as accidental. It is, in fact, the fulfilment of the conjecture thrown out a century earlier by William Herschel in "The Philosophical Transactions" of 1783, in a paper entitled "On the Proper Motion of the Sun, &c." The very title of that paper is justification of the word of warning we have just uttered as to the difficulty of keeping quite clear the meaning of the term Proper Motion. Even in a modern syllabus we have the expression "The Proper Motion of the Sun" used to describe its apparent annual motion among the stars, so it is little wonder if the term Proper Motion is a stumbling-block to many a beginner. We may perhaps state here once for all that the Proper Motion of a star is the minute change of the *apparent* position which it occupies *with reference to the other stars*; it would require too much space were we to attempt to bring out the full meaning of the words placed in italics.

Proctor's word "drift" has recently been appropriated to a far larger process of which he had no means of knowing. The story of Kapteyn's "Two-Drift Theory" does not enter into the scope of this article, and we need some word which we can use for the much more limited groups to which we now refer. By a happy inspiration Professor Turner has given them the name of "Migrating Stars,"* the various flocks of which need not, of course, be moving in the same direction, but the individual members of each flock will be distinguished by the fact that their motions are parallel and equal. Some of the members of a flock may have passed us—some may be passing on the right, some on the left, while some are still approaching us. Thus we may have to look to all points of the heavens to pick out the components of any one flock.

"Parallelism and equality of motion" are Proctor's words, and we shall presently see how the investigation has carried us now to a point where both those features vanish, and yet the main idea not only remains true, but is vastly enlarged. This is only one more instance of the growth of ideas; the very characteristics by which originally they were defined are discarded, and yet the idea remains.

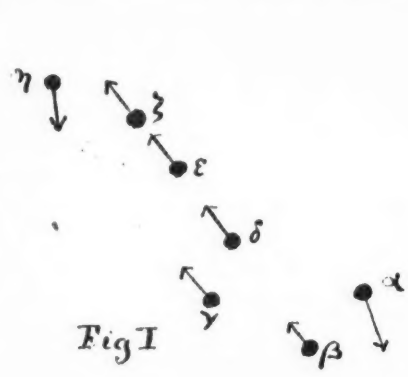


Fig I

Fig II

The best-known cases of equal parallel motion are perhaps the Pleiades and the Great Bear. The arrows in Fig. I give by their length and direction the most recent values of the proper motions of those stars. Proctor's discovery is seen at a glance.

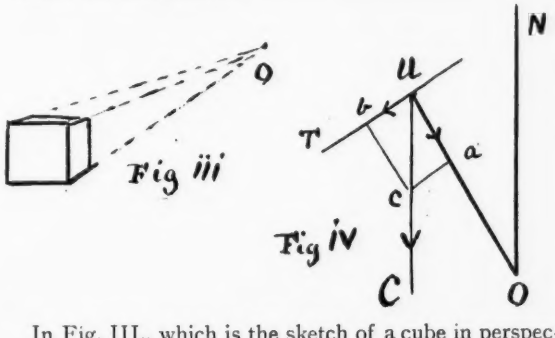
Five out of seven are moving in a common progress. the other two obviously do not belong to them. In Fig. II. we have the arrangement as it will be in 100,000 years as seen by an observer in the solar system. It may justly be urged with regard to Fig. II. that we are multiplying observed quantities by at least 1000, and consequently their errors too. The thousandth part of the length of one of the arrows is a mere point, the uncertainty then of *the direction* of that fraction must surely be very great. The criticism is unquestionably reasonable, and we cannot give the space now to meet it, but we can only state that not only is Fig. II. accepted by men who are competent to judge of the evidence, but also the much wider inferences to which we shall presently refer are considered sound by our leading authorities.

* Proc. R. S., Vol. XVIII., p. 169, and "Other Worlds Than Ours," p. 269.

* "Fortnightly Review," Jan., 1910.

Before continuing the story of these five stars, we will describe another flock of migrants detected by Professor Lewis Boss in the constellation of Taurus.* Professor Boss, of Albany, will be remembered in the annals of astronomy "for his long-continued work on the positions and proper motions of fundamental stars," to quote the words in which the award of the Gold Medal of the Royal Astronomical Society was made to him in 1905. One of the by-products of his exhaustive and accurate work, which, by-the-by, was undertaken in order to stake out the 49th parallel of latitude as the boundary between Canada and the United States, was the detection of the fact that 39 stars in Taurus have proper motions directed towards one spot on the celestial sphere. He gave the name "the convergent" for this point, and it will be readily admitted that it must be "the vanishing point" of a sheaf of parallel tracks. In this case the component stars are scattered over a circular region of the sky so large that six out of the seven stars of the Great Bear could lie on it. As a cluster, therefore, those 39 stars are extremely loose and in no way catch the eye, the individuals being quite faint stars. Let the imagination, however, be projected forward some sixty million years, and the convergence of the tracks will have brought them all on to a smaller space than is now occupied by the Pleiades. If then the cluster will thus condense by mere perspective and the lapse of time, may we not argue backwards and suggest that the compact clusters which we now see might have appeared many million years ago as mere scattered stars apparently quite dissociated, and may we not go on to suspect that the actual distances between the components of a star cluster may be comparable to the distance which separates us from the nearest of our stellar neighbours? To have written such words a couple of years ago would have laid one open to the charge of indulging in unguided speculation; this single group of stars has very greatly widened the limits within which our imaginations may safely play.

In this case, therefore, the parallelism of Proctor's arrows has given place to a convergence of the apparent motions. But the essential feature of parallel motion does not disappear; it is, in fact, brought out more strikingly, and a perspective is added which immensely increases the picturesqueness of the whole conception. The impression that the starry sky is a mere shell or vault is only too easily forced upon us, but here we have a third dimension, the depth of space, illustrated vividly before our imagination.



In Fig. III., which is the sketch of a cube in perspective with the vanishing point, O, of three edges shown, we know that any other line parallel to those edges must, if produced, go through O; and for an inverse reason the line of sight from the observer's eye to O must be parallel to those edges.

If then one looks at the vanishing point one is looking in a direction parallel to the lines that there vanish. When shafts of light are seen radiating from the sun, we know that they are really all parallel and their common direction is given us by the line from our eye to the sun, although it must be frankly admitted that it requires a real control over the imagination to make it assent to this unimpeachable truth. Now the point O corresponds to "the convergent" of Boss' cluster, but supposing all his proper motions had been on the same lines but in the opposite direction, then we should have to call O "the divergent," and "the convergent" will be in the diametrically opposite direction from O. Suppose a rod pointing at O, and suppose we look the other way along it, our line of sight would be parallel still to the motions of the stars and we should be looking at P, "the convergent." We shall have to use this little proposition in our next example of a flock of migrating stars.

Returning once more to Proctor's five stars, his information only warranted him in asserting that the arrows were "sensibly parallel"; the more precise determinations made by Dr. Ludendorff* from recent catalogues shows us that those arrows are not parallel, but the arrangement is only the more remarkable for they all diverge with extraordinary accuracy from a single spot at R.A. 123° Dec. 37° N. One might be tempted at first to exclaim that Proctor's whole foundation was obviously rotten if once parallelism is disproved; it was pure luck that led him to associate these five stars, and Fig. II. must also be unreliable. And yet, as a matter of fact, we have drawn both Fig. I. and Fig. II. from these modern values of the proper motions. The "divergent" happens to be placed precisely on the line that so nearly passes through ζ, ϵ, δ, and β at a distance to the right of β equal to twice the distance from ζ to β. We will call the divergent D, and its antipodes, which is therefore the convergent, shall be called C. It is easy to picture these two points to oneself on the sky if one recalls the appearance of the Great Bear on a September evening lying in the N.W. about as shown in Fig. I. D will then be the actual north point of the horizon and C will be the exact south point of the horizon (speaking for an observer in lat. 53° N.). Accordingly at such a moment a rod placed horizontally N. and S. gives us *completely* the direction of the motion of this flock of stars past us. Each arrow on the sky-vault, giving a proper motion, only indicates *partially* the direction of flight, but if we may assume that the convergence means parallelism in perspective, then we know from the convergent the *complete* motion relative to ourselves.

Returning to the actual sky on the September evening at Sid. time 20 hours, *i.e.*, about 8 p.m. on 21st, suppose we hold a square card with one edge horizontally N. and S., and tilt the west side up about 50°, we shall find we can draw lines on it which point quite straight to β, δ, ϵ, and ζ Ursæ Majoris (γ will be a little below the plane), and we will select β for the moment to represent the group. Let O N Fig. IV. be the edge of the card pointing horizontally North, and OU be directed to β. The angle NOU will be 29°. Then taking U anywhere on this line, U can represent the star β and a line UC drawn parallel to NO represents the direction of β's motion, because it is pointing at C, the "convergent" or vanishing point. For the present we know nothing about the magnitude of this motion in miles per second, but let us take a length Uc to represent this unknown velocity, and we can split it up by the usual methods into Ub perpendicular to UO and Ua along UO.

* "Astl. Journal," No. 604.

* Ast. Nach. 4313.

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We must not say that Ub is the proper motion of the star because proper motion is an angle and Ub on our diagram is a distance, but they are related by the fact that Ub equals the angular motion multiplied by OU, the distance of the star.

Now the distance of none of these stars is known, and it is an interesting fact that from the detection of their convergent motion we can deduce their distance, for we shall presently see that we can calculate the value of Ub, and we know, of course, the angular motion. In the case of β this is 8″·7 per century.

Passing now to the component Ua, which is the radial or line of sight motion of the star. Dr. Ludendorff has elaborately discussed this question, which is extremely difficult for reasons which we must pass over. For β he obtains the value − 16·8 km., which means an approach of 10½ miles per sec. We may therefore say that Ua = 10½, and since the angle CUa = NOU = 29° we can deduce that Uc = 11½, and we have at once the velocity of progress of the whole system; it is 11½ miles per sec. Now we can go on to compute Ub, which must be 11½ cos 61° = 5½—and a little arithmetic will show that if β moves 8″·7 per century, and this is really 5½ miles per sec., β must be about 400 billion miles away—this would mean a parallax of about 0″·05, which is by no means unreasonable. It may be of interest to remark that according to Professor Kapteyn's statistical estimates a star of the magnitude of β with a proper motion comparable to that of β might be expected to have a parallax 0″·025. This may be regarded as quite a fair agreement.

So far we have spoken only of β; it will be well to have it clear what quantities we demand from the other stars if they are to be accepted as parts of the same flock.

(1) Their proper motions must diverge from D—or converge on C.

(2) Any known facts about their distance, radial motion, and amount of proper motion must fit in with the assumption that the velocity of the flock is 11½ miles per sec. It is extremely unfortunate that for these stars the radial velocities are difficult to ascertain because they appear to be variable. Dr. Ludendorff establishes β as a spectroscopic Binary, and satisfies himself that ϵ is so too, while ζ has long been so recognised. He obtains for ϵ and ζ the radial velocities −13 and −12·6 km. If they belong to the flock those quantities should be −13·2 and −12·2, so this is a fairly strong corroboration, but the main strength of the argument in favour of these five forming a flock is the convergence of their *directions* of proper motion, and their general similarity of magnitude and spectrum and possible duplicity.

We now come to a very pleasing development of this research. Dr. Hertzsprung has sought for other possible members of this flock, not confining his scrutiny to the immediate neighbourhood of Ursa Major.* The two criteria above mentioned were his guides, the former of the two being naturally first applied. He found six stars whose motion fairly well converged on the point C, R.A. 303° Dec. − 37°, and one would naturally expect that some such result would emerge in reviewing any extensive list of stars. We must not then give much weight to the possible connection unless the second criterion is also satisfied.

Now the only star among the six for which we have the necessary information as to radial velocity and distance is Sirius, and the fact that the evidence is entirely satisfactory will be an exceptionally popular addition to Stellar Astronomy.

* "Astrophysical Journal," XXX., p. 135.

In the first place, the arrow of Sirius' proper motion is directed nearly precisely to the point C, and since the length of that arrow is ten times as great as any of Proctor's five stars it affords to that extent a more delicate test. Then the parallax of Sirius is well determined; the Nautical Almanac only recognises officially three parallaxes—those of Sirius and Centauri, and 61 Cygni, giving that of Sirius the value 0″·37. The radial velocity of Sirius has known many vicissitudes, and is at present accepted as − 7·4 k.m.; that is to say, *the Sirian system* is approaching us at about five miles per second.

On the September evenings, when C and D are so conveniently placed on our horizon, Sirius is not far from the Nadir; but without troubling to give the steps of computation it will suffice to state that the second criterion would demand from Sirius the following qualifications:—

Parallax should be . . . 0″·387; it is 0″·37
Radial velocity should be . − 8·5; it is − 7·4

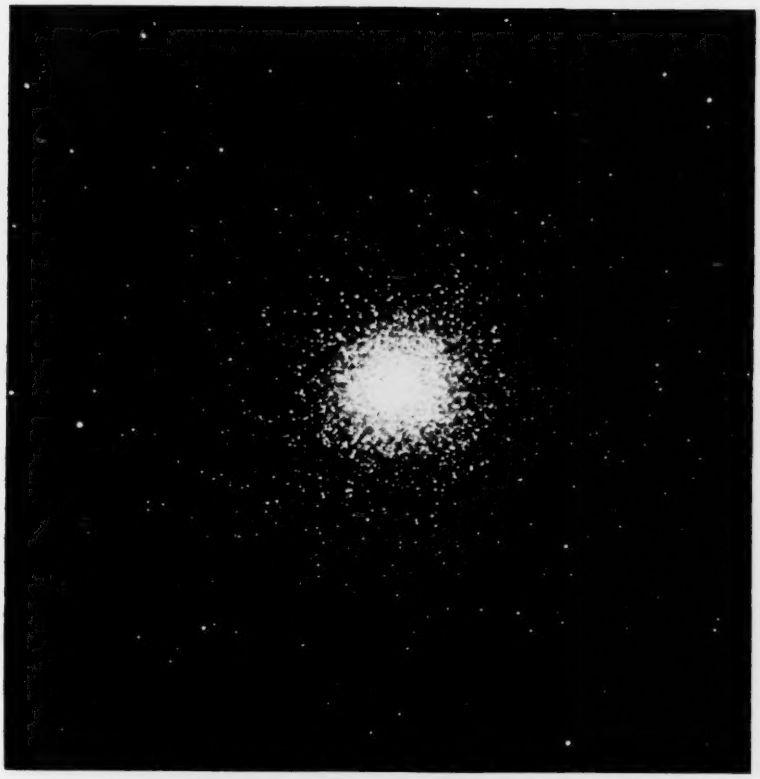
This accord justifies us in stating with confidence that Sirius belongs to the same flock as Proctor's five stars, and Mr. Eddington has remarked: "It would have been an interesting theme for the classical mythologists to explain how so important a part of the Great Bear has come to be situated between the teeth of the Great Dog."

There are two further striking inferences to be made from the distances which this discussion discloses. The actual stars of the Great Bear must be from 30 to 130 times as luminous as our sun—which places them, according to Kapteyn's estimates, among the larger of the heavenly bodies, for he only admits about 12 per cent. of the stars to be intrinsically more luminous than the sun. And, secodnly, this stream, the existence of which is now accepted, comprises within its limits stars separated from each other by distances up to 30 light-years, say 600 billions of miles.

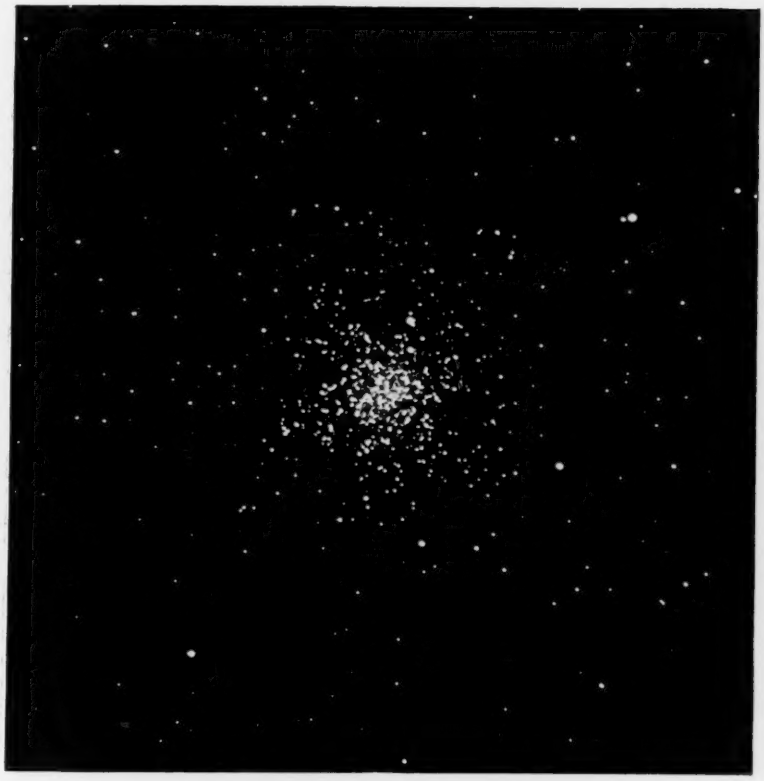
We pointed out at the beginning of this article that the doctrine of the Fixity of the Stars, immeasurable though its value has been, must now be abandoned, but we may begin to see that its place will be filled by another conception no less stimulating. In the place of the incorruptible crystalline sphere with its fixed stars we have opening gradually before us the appalling picture of the immensity of the Universe. The utilitarian who points to navigation and to frontier-staking as the uses of astronomy merely convicts himself of being a shallow philosopher. Surely the words of Sir John Herschell, which the British Association printed in the Preface of their Star-Catalogue, gauge more truly the real "use" of our science, emphasising as they do the ideas of Fixity and Immensity. "The stars are the landmarks of the Universe, and, amid the endless and complicated fluctuations of our system, seem placed by the Creator as guides and records; not merely to elevate the mind by the contemplation of what is vast, but to teach us to direct our actions by reference to what is immutable in His works."

A WRITER in *Cosmos* states that he possesses a tame magpie, to which he sportively offered an extinguished cigar stump. The bird began to tear the stump apart but, apparently changing its mind, proceeded to rub the stump, held in its beak, over every part of its body, including the inside of the wings, in a very careful and methodical manner. The experiment was subsequently repeated many times, always with the same result. The magpie is so fond of tobacco that it has repeatedly snatched a lighted cigar from his hand, against his will. It also picks up fallen cigar ashes and strews them over its feathers. He thinks these actions have a purpose, the destruction of parasites, and are determined by atavism or inherited instinct. In the wild state, some unidentified plant must have been used, instead of tobacco, as an insecticide. The magpie's action, furthermore, seems to be an unquestionable instance of the use of "tools" by a lower animal.

XUM



The Star Cluster M 13, Herculis.



The Star Cluster M 12 Ophiuchi.

Reproduced from "Photographs of Nebulæ and Clusters made with the Crossley Reflector by James Edward Keeler," the Memorial Album published as a tribute to Professor Keeler's memory by the Lick Observatory.

XUM

The Conservation of Mass.

By ALFRED W. PORTER.

(*Continued from last month, p.* 13.)

ONE of the most important differences between old and new views of electricity is that it has now been proved that electricity possesses inertia or mass. All early attempts to detect any property of this kind failed completely. It is true that there were phenomena known which simulated the effects of inertia. These are the phenomena connected with self and mutual induction. The fact that an electric current started in a wire only increases gradually (however quickly) in strength is a fact precisely analogous to that of the gradual change in velocity of a massive body when a force is applied to it. But however analogous these effects may be to those arising from inertia, it soon became abundantly clear that it cannot be the inertia of electricity which they reveal, because the effects of self-induction are modified by bringing a piece of iron *near* the electric circuit, and they change very much with a change in the form of the circuit. Take in the one case a circuit consisting of a single turn of wire opened out into a circle, and in a second case squeezed up so that the direct and return paths are as near together as possible—a current changes in quite a distinct way in the two cases. So if we desired to refer the whole of the apparent inertia to the moving electricity it would not have a constant value, and would therefore not have the same utility that the conception of mass has in connection with ordinary matter. But, again, if a non-conducting obstacle is interposed in a conductor—*e.g.*, if a piece is cut out of a conducting plate, the current is found to flow past the obstacle quite differently from the way a current of water would flow past a similar obstacle. The current flows round sharp bends, and no evidence is obtained of a reluctance to do so. (Though in recent years it has been claimed that it does appreciably tend to continue straight on, this claim requires to be substantiated.) All such phenomena were against the conception of the massiveness of electricity even if electricity were a substance at all. Yet, as there was no evidence as to the quickness with which it moves in a conductor the results were certainly not decisive. The electric current is a measure of the total amount which flows through a cross section of the conductor in unit time. If there is a great deal in each unit volume it will need to go only slowly; if there is very little the velocity must be correspondingly great. Now to walk round a sharp corner and to run round it are very different performances. If electricity only crawls in conductors it must be difficult to prove whether it has inertia or not. Recent experiments which we shall deal with later show that the velocity is only about one ten-millionth of a centimetre when there is a drop of one volt in each centimetre of the conductor. High velocities would make the detection easier. Cases in which the velocitie are *very* high have been obtained in recent years.

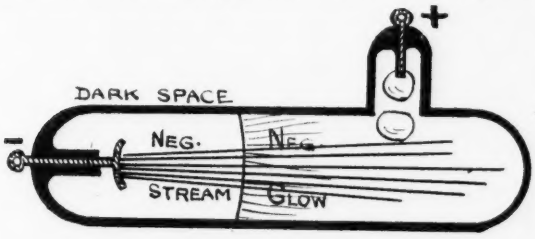


Fig. 1.

But there is another difficulty. As long as electricity is entangled in a conductor, if we move one the other moves too. A coil carrying a current when placed in a magnetic field tends to turn so that its axis shall lie along the field. Now whether the magnetic field acts directly on the electricity and it in turn upon the conductor, or whether it would be truer to say that the magnetic field acts directly upon the conductor is of no importance as far as final effects are concerned. The coil starts moving in obedience to the force upon it, with a determinate acceleration. Here again is evidence of inertia, but it is the inertia of the moving coil. Unless electricity can be disentangled from matter it does not seem to be possible to separate its own inertia from that of the associated matter.

The advances in recent years are entirely due to the discovery of cases in which electricity is apparently disentangled from matter and at the same time is moving very fast.

Faraday had discovered that the electric discharge in a vacuum tube is different at its two ends. Plücker and Varley showed that from the negative terminal, with the surrounding gas at appropriate pressures, a shaft of bluish light starts and proceeds in straight lines across the other luminous effects in the tube which encloses the rarefied gas. This is the cathode stream (Fig. 1). It was specially studied by Hittorf, Puluj, and Crookes. Hittorf showed that when a magnetic field is excited at right angles to the initial direction of the stream this bends into a circle lying in the plane of the figure when the magnetic field is at right angles thereto. Crookes surmised that we had to deal here with a fourth state of matter—a guess which had the required novelty, but did not carry one much further. Continental investigators thought it was a new kind of disturbance in the ether, but were brought to a standstill by the fact that rays of light are not bent in a magnetic field. Then there came a long interval during which no vital discovery was made. At last Lenard's investigations awoke fresh interest. By placing an aluminium window in the wall of the tube at the place upon which the blue column struck a similar glow appeared outside. If the outside space were also enclosed in a tube which could be evacuated, the glow in it was a similar shaft of light when the vacuum was high, but became more diffuse when the pressure was not so small. It affected a photographic plate, and this property enabled absorption experiments to be made. The absorption of different bodies turned out to be nearly proportional to the densities of these substances. This was a new type of absorption not to be found in any other phenomenon, whether radiant or otherwise. Next came early attempts at measuring the "velocity" of the stream. Causing it to leave a phosphorescent patch in the tube near the electrode and again a long way from it these patches were brought by means of reflections into near coincidence (optically speaking). If then one of the reflecting surfaces is a mirror capable of quick rotation and it be set rotating, the images will still appear coincident if they are practically simultaneous, but will otherwise be separated. From the separation and the rate of rotation of the mirror their velocity is calculable. It came out about 2×10^7 centimetres per second; a number which went against the idea that it was a merely ether disturbance that was being investigated; for transverse vibrations in the ether would have the velocity of light (3×10^{10} cms. per second), while longitudinal ones, if such exist, must be amazingly more rapid.

At last came the discovery of Röntgen rays near the end of 1895. From that time to this the vacuum tube has ceased to be little more than a toy; it is now one of the

regular pieces of apparatus of investigation in every physical laboratory.

The next important advance was when J. J. Thomson proved experimentally that the cathode stream is bent by a magnetic field into equal circles, provided that the magnetic field and the voltage applied to the tube are the same, *whatever the nature of the gas contained in the tube or the metal of which the electrode is made.* The present writer has always considered that this was one of the most critical discoveries in the history of this subject; because it showed that whatever it is that we have to deal with in the stream it is exceedingly unlikely to be the same matter as that of the particular electrode or gas.

In order to connect together the magnitude of the magnetic field and the deflection, the following theorems are necessary:—

(1) Unit length of a current C placed at right angles to a magnetic field H is acted upon by a force at right angles to both, and whose magnitude is CH.

(2) An electric charge E moving with velocity v behaves like unit length of a current of magnitude Ev.

Select three directions at right angles to one another; if the charge is moving in one of these directions, and the magnetic is directed along a second; then it experiences a deflecting force, along the third direction, of magnitude EvH.

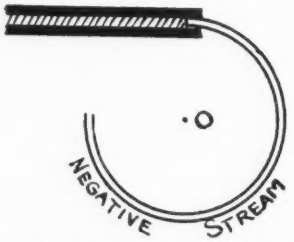


Fig. 2.—Magnetic field at right angles to paper; deflecting force in the plane of the paper acting towards O.

Now we shall suppose that each unit volume of the stream consists of such a charge, E, shot out with velocity, v. *Since it does not bend abruptly at right angles under the action of the magnetic field it must possess a property analogous to inertia.* Let this inertia be M for each unit volume.

The problem now is analogous to that of a massive stone whirled round under the deflecting action of a string with uniform velocity in a circle of constant radius—say R; for the magnetic field continues to act at right angles to the motion after any deflection has taken place (Fig. 2). In such a case the centripetal force is measured by $\frac{Mv^2}{R}$. In the case of a stone this force is supplied by the string; in the case before us, by the magnetic field. But the force due to the latter is EvH; hence

$$\frac{Mv^2}{R} = EvH$$

or $$Mv = E.RH.$$

An examination of this equation will show what can be logically concluded from the constancy of R for the same H. It may be stated thus, since Mv is the *momentum* of unit volume of the stream:—

The momentum of unit volume of the stream must bear a constant proportion to the charge per unit volume for all gases and electrodes.

The only alternative, then, to the supposition that in every case the material of the stream is the same is to suppose that a peculiar relation holds in all cases between its momentum and its charge.

(*To be continued.*)

The Triphenylmethyl Problem.

By HERBERT H. HODGSON, M.A. (Camb.), B.Sc. (Lond.), Ph.D. (Heidelberg).

PART I.

GENERAL THEORY OF THE TRIPHENYLMETHANE DERIVATIVES.

IN the science of Organic Chemistry the derivatives of triphenylmethane occupy an exceptional position owing to the peculiar properties they exhibit, and recently have attracted special notice in the scientific world.

These remarkable characteristics are manifest even in the simplest derivatives, and are to be explained by the fact that the union between the group $(C_6H_5)_3C-$ and the radicle combined with it is exceedingly weak.

Hanriot and St. Pierre have found that even in triphenylmethane itself, $(C_6H_5)_3C-H$, the united hydrogen atom is easily replaced by potassium, a proof of the remarkable mobility of this particular hydrogen atom.

Baeyer and others have established that the hydroxyl group in triphenylcarbinol, $(C_6H_5)_3C-OH$, is even more mobile than the hydrogen in triphenylmethane, since it readily condenses with such bodies as phenol, aniline, and phenylhydrazine, and, still more noteworthy, is replaced by chlorine if a stream of hydrochloric acid gas is merely passed through a benzene solution of triphenylcarbinol.

Every radicle attached to the $(C_6H_5)_3C-$ group appears to possess great mobility, but more especially so the chlorine atom in triphenylchlormethane, $(C_6H_5)_3C-Cl$, which allows itself to be detached with the greatest ease; a behaviour very similar to that of the chloride of a weak metal such as aluminium.

To explain this instability Werner has put forward the following hypothesis—viz., that the affinity possessed by the methane carbon atom is almost wholly required by the three phenyl groups, and for the fourth valence only an insufficient amount of affinity remains, which in triphenylmethane is more than satisfied by the hydrogen atom. The weak union is therefore due to the fact that the valence of the hydrogen atom is not completely satisfied by the triphenylmethyl residue, and the excess of affinity gives to the compound the capability of forming addition products with benzene, aniline, &c.

This property of forming double compounds, which is peculiar to triphenylmethane and its derivatives such as triphenylchlormethane, is explicable on the foregoing hypothesis.

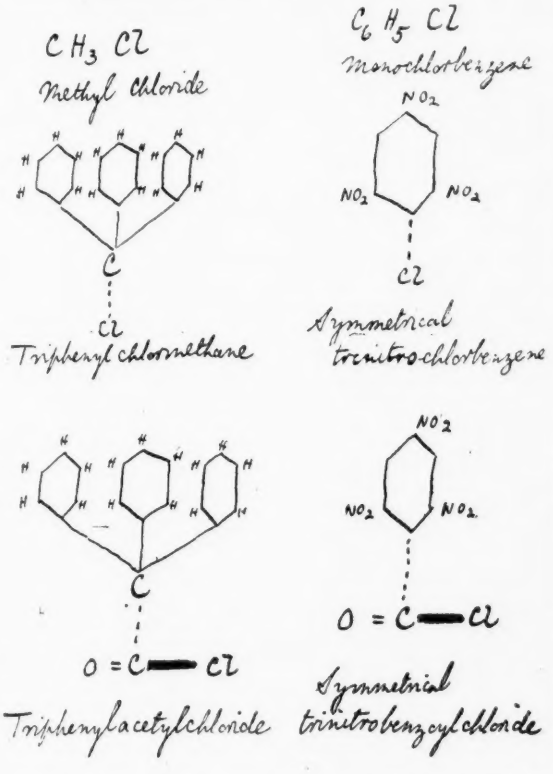
Werner is of opinion that the negative character of the phenyl groups is not responsible for the ease with which the chlorine atom in triphenylchlormethane can be split off, for in comparison with the much stronger benzoyl groups in tribenzoylbrommethane, $(C_6H_5CO)_3C-Br$, the bromine, on the contrary, is much more difficult to take away. Flürscheim holds the view that the negative characteristics of the phenyl groups essentially contribute to loosening the union of the chlorine atom with the triphenylmethyl residue, and should this view be correct then we must expect that the even more negatively influenced acid chloride of triphenylacetic acid, $(C_6H_5)_3C\,CO\,Cl$, will have its chlorine atom extremely mobile. As a matter of fact, the extreme opposite is the case, for in this acid chloride the chlorine is so firmly united that on heating a sample of the substance for a short time with dilute caustic potash only a part was decomposed.

The explanation of the above phenomena follows readily on Werner's hypothesis, for if in triphenylchlormethane affinity remains over owing to the insufficient union of

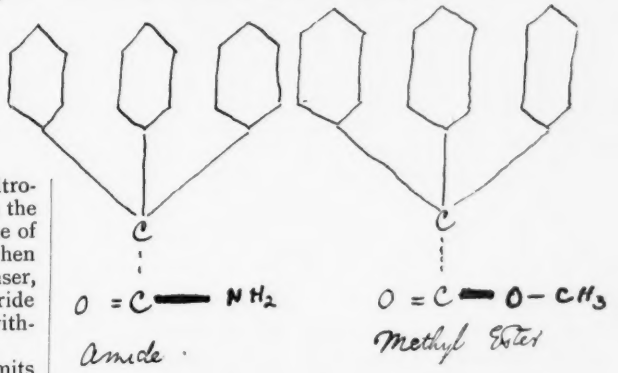
the chlorine with the triphenylmethane residue, then something similar must take place with the chloride of triphenylacetic acid. Owing to the ease with which this acid chloride parts with carbon monoxide, viz., when heated to its melting point of 120° C., it follows that the carbonyl group is very loosely united with the triphenylmethyl residue, and it is therefore to be expected that the remaining part of the affinity belonging to the carbonyl group serves to make the union of the chlorine atom still more secure.

Victor Meyer has found a similar phenomenon in the case of the chloride of symmetrical trinitrobenzoic acid $C_6H_2(NO_2)_3\,CO\,Cl$. In benzoyl chloride the chlorine atom is easily removed, but the reverse is true of symmetrical trinitrobenzoyl chloride, for this, when heated with water for an hour under a reflux condenser, remained for the greater part unchanged. The chloride of triphenylacetic acid is even more stable since it withstands the action of dilute caustic alkali.

This similarity between the above acid chlorides admits of a parallel explanation, for exactly as the entrance of three phenyl groups into methyl chloride weakens the union of the chlorine atom, so the entrance of three nitro groups into monochlorbenzene causes the chlorine atom to acquire great mobility. If, however, in both cases we allow the union of the chlorine atom (in the one case with the triphenylmethyl residue and in the other with the trinitrophenyl residue) to be indirect by means of a carbonyl group, then we have in each case the circumstance of an excess of affinity belonging to the carbonyl group, which is exerted to make the union of the chlorine atom with it still more secure. In the following diagrams dotted and thick lines represent weakened and strengthened unions respectively.



As with the chloride, so with the amide and esters of triphenylacetic acid the greatest difficulty has been experienced in attempting to saponify them. The intensified unions are shown diagrammatically as follows :—



The reaction between the methyl ester of triphenylacetic acid and phenylmagnesium iodide affords an excellent illustration of the above theory, for instead of the interchange of the methoxyl for the phenyl group according to the equation :—

$$(C_6H_5)_3\,C\cdots CO\text{-}\boxed{OCH_3 + I\,Mg}\,C_6H_5$$

$$= (C_6H_5)_3\,C\,CO - C_6H_5 + CH_3\,O\,MgI$$

the methyl group was split off with the formation of a magnesium salt of triphenylacetic acid as in the equation :—

$$(C_6H_5)_3\,C - COO\,\boxed{CH_3 + C_6H_5}\,MgI$$

$$= (C_6H_5)_3C\,CO\,O\,MgI + C_6H_5\,CH_3$$

Clearly then the magnesium compound is not able to split the ester between the carbonyl and methoxy groups, as is usually the case, since the carbonyl group possesses an excess of affinity and is thereby strengthened, but must attack the weaker union between the methyl and carbonyl groups as in the diagram :—

$$(C_6H_5)_3\,C\cdots CO - O\text{-}|\text{-}\,CH_3$$

In the acid chloride of triphenylacetic acid the above possibility does not present itself, and therefore the Grignard reaction takes place in the usual manner, *e.g.* :—

$$(C_6H_5)_3\,C\cdots CO - \boxed{Cl + I\,Mg}\,C_6H_5$$

$$= (C_6H_5)_3\,C\,CO\,C_6H_5 + Cl\,MgI$$

The instability of bodies containing the triphenylmethyl residue is further exhibited by the unsymmetrical tetraphenylethane, $(C_6H_5)_3\,C\,CH_2C_6H_5$, which on being heated with phosphorous pentachloride splits off hydrogen and rearranges itself to form tetraphenylethylene. Pentaphenylethane is even more unstable, since decomposition takes place at the melting point, and when heated with phosphorous pentachloride it forms triphenylchlormethane.

The greatest instability of all must be expected from a structure which is built up of two of these triphenylmethyl residues, and such a body possessing these expected properties has been discovered by Gomberg who in 1900 gave to the scientific world the mysterious compound which he called triphenylmethyl.

(To be continued.)

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The Messina Earthquake.

By CHARLES DAVISON, Sc.D., F.G.S.

A GREAT and complex earthquake, like that which ruined Messina and Reggio at the close of 1908, requires investigation from many points of view. The subject is too large to be undertaken by one man, and the different aspects of the earthquake, as seen by observers trained in more than one country, are necessary for the formation of a complete picture of the greatest disaster of modern times. Dr. Mario Baratta, the historian of Italian earthquakes, undertook the investigation of the earthquake generally under the auspices of the Italian Geographical Society. Prof. G. Platania has made many observations on the sea-waves which wrought so much additional destruction after the shock was past. Ample materials for studying the propagation of the unfelt earth-waves are being collected by the Italian Geodynamic Office. Prof. Omori, the director of the Seismological Institute at Tokyo, spent two and a half months in the stricken area, making various inquiries, while his colleague, Prof. T. Nakamura, examined the effects of the earthquake from a builder's point of view. From the scrutiny of these and other careful observers, we cannot fail to learn much with regard to the nature of the earthquake phenomena, and the final reports will be awaited in the confident hope that considerable light will be thrown by them, not only on this particular shock, but on the origin of earthquakes in general. In the meantime, Dr. Baratta and Prof. Omori have issued preliminary reports in which are briefly stated the principal conclusions at which they have arrived. These conclusions are of great interest, and of sufficient value to justify the summary and comparison of them here given.

Many great earthquakes, and especially those of Southern Italy, are preceded by weak shocks in different parts of the meizoseismal area; but the Messina earthquake was practically unheralded by any timely warnings. A few slight tremors are reported, but there is no trace of them to be seen on the records of the very sensitive seismographs at Messina, which is within the meizoseismal area, or at Mileto and Catania, which are not very far distant. The shock burst suddenly on the sleeping inhabitants at 5.21½ a.m. (or 4.21½ a.m. Greenwich mean time), and it is, of course, to its occurrence at this early hour that the heavy mortality was largely due.

Meizoseismal Area.—The form and position of the district chiefly affected are shown in the sketch-maps in Figs. 1 and 2. The former is reproduced from the map given by Dr. Baratta, the curves marked A, B, C, and D representing isoseismal lines of varying degrees of intensity. The area included within the innermost isoseismal (A) is the very disastrous zone. In the band between the curves A and B the shock was disastrous, in that between the curves B and C almost disastrous, and in that between the curves C and D it is described as ruinous. According to Dr. Baratta, the greater part of the meizoseismal area, with its centre, lies in Southern Italy, the boundary passing only a short distance to the south and west of Messina. Prof. Omori's map of the area of the violent motion (Fig. 2) differs slightly from that given by Dr. Baratta, the difference being partly due to the standard of intensity adopted as prevailing at the boundary, partly perhaps to the methods employed by the two observers. Professor Omori's curve is elliptical in form, its longer axis is directed north and south, and its centre clearly lies beneath the straits of Messina. But the remarkable feature of both curves is the extremely small area embraced by them, that included by Prof. Omori's curve being about 18 miles long and 12 miles wide.

Within this area, the loss to life and property was excessive. According to Prof. Omori, "the enormity of the destruction of Messina is really beyond one's imagination. All the buildings in the city were, with very few exceptions, considerably cracked or absolutely reduced to masses of ruin, which looked like hills of *débris;* even those houses, whose perimetral walls were not overthrown, had their roofs and floors knocked down from top to bottom, so that the inside was filled with *débris;* it being not rare that fifteen or more dead bodies were found buried one upon the other in the space of a single small room on the ground floor. The city streets, whose maximum width was less than about 11 metres, were covered by the *débris* of the houses, whose height varied from 40 to 60 feet. Especially, the two principal streets, namely, the Via Cavour and the Via Garibaldi, were completely blocked by masses of stones and mud, whose average height was about 5 metres. Under such circumstances, it was certainly impossible for the majority of the people to save themselves, even if they had succeeded in escaping out of doors."

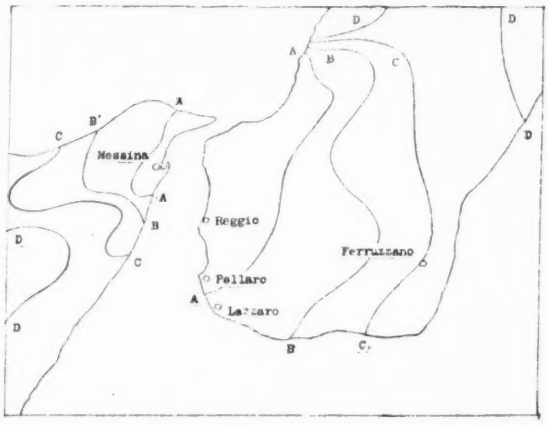

Fig. 1.

It is, of course, owing to the existence of two large towns—Messina on the one side and Reggio on the other, with populations in 1908 of about 150,000 and 40,000 respectively—that the Messina earthquake stands so prominently among other and still stronger Calabrian earthquakes. The total number of victims in the two towns in all probability will never be known. Dr. Baratta refrains from making any estimate, but Prof. Omori believes that about 75,000 lives were lost in Messina and its suburbs, and about 25,000 in Reggio and other places in Calabria. With these exceptions, the mortality reached a maximum at Canitello, where 43·7 per cent. of the population perished; at a few other places it ranged from 30 to 20 per cent.; in still more from 20 to 10 per cent.; while in a very large number of places the death-rate was lower than 10 per cent. In Sicily, the mortality outside Messina was greatest at Faro Superiore, where it was as much as 33·2 per cent. of the inhabitants.

In the area of greatest devastation, some curious variations of intensity were exhibited, houses being found as if miraculously preserved among others completely ruined. For instance, in the neighbourhood of Messina, the village of Contemplazione was distinctly less injured than the neighbouring villages of Paradiso and Annunciazione

On the other hand, certain areas of increased intensity were noticed far outside the epicentral district, and these correspond with what are known as "seismologically dangerous zones," or districts most strongly shaken by other Calabrian and Sicilian earthquakes—such as the Monteleone zone disturbed in 1905, the Piana in 1783, and the Ferruzzano zone in 1907.

Position of the Epicentre.—The curves given in the two sketch-maps (Figs. 1 and 2) leave us in some doubt as to the position of the centre. From Dr. Baratta's map we should infer that the origin was beneath the land, from Prof. Omori's that it was beneath the straits. Other evidence bearing on this point is, however, given by some interesting observations made by Prof. Omori on the direction of the strongest part of the shock. In other

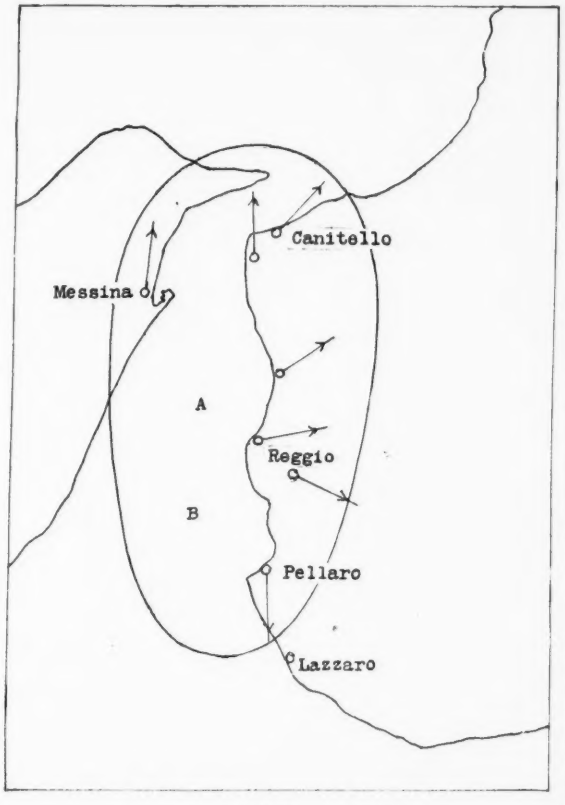

Fig. 2.

earthquakes, he has shown that the average direction of fall of a number of columns or other bodies agreés closely with the direction of the principal vibrations as recorded by seismographs. In the Messina earthquake he ascertained the average direction at seven places, represented by the arrowheads in Fig. 2; and these, for the most part, diverge approximately from a spot indicated by the position of the letter A on the map. It is therefore probable that the seismic focus, or at any rate the principal part of it, lies beneath the straits of Messina.

Sea-Waves.—As is usually the case with strong submarine earthquakes, the shock was followed by a series of sea-waves which swept both shores of the straits, and in many places increased the tale of the disaster. After an interval, which varied in different parts from a few minutes to ten minutes, the water first retired from the shores, then returned with violence, rushing over the low-lying reaches of the coast, and for some time afterwards remained in a state of marked agitation. Along the Calabrian shores the destructive effects of the waves were exhibited over a distance of 23 miles, from Cape Pezzo on the north to Cape dell'Arni on the south. On the opposite coasts, they were spread over a much greater distance, of not less than 60 miles, from Grotto (3 miles north of Messina) to near Catania. The greatest damage occurred on the coast of Calabria between Pellaro and Lazzaro. A railway bridge girder, 45 yards long, was thrown down in this district, many houses were shattered and their ruins removed, and the sandy shore ground, to a width in places of more than a hundred yards, was swept away. At Reggio, a large concrete block, 8½ feet long, 8 feet wide, and 4 feet thick, was torn from the pier and carried by the waves to a distance of more than 20 yards.

A remarkable feature of these waves is that a great height was attained at several places where the violence of the shock was perceptibly diminished. At Reggio, indeed, they rose as high as 32 feet, but the maximum height of 35 feet was reached along the Calabrian coast between Pellaro and Lazzaro. Immediately opposite this point, on the Sicilian coast, the waves were 28 feet high; in the harbour of Messina, they were not above 9 feet, but on the unprotected coast to the south they were 23 feet, and on that to the north 15 feet high. At the north end of the straits, the waves died out rapidly, being only 2½ feet high at Faro, though they were sensible for some distance both to the north and south, and were quite noticeable at Malta. They were registered by tide-gauges at Porto d'Ischia, Naples, Civitavecchia, and Porto Corsini, and even affected those in the neighbourhood of Venice.

From the great height of the waves near Pellaro and on the opposite coast, Prof. Omori concludes that the main origin of the sea-waves was near the spot marked B in Fig. 2, but he thinks that there may have been a secondary centre of sea-waves near that indicated by the letter A, which appears to be that from which the earthquake-vibrations radiated, or possibly that there were two centres forming together a continuous zone of disturbance.

The cause of the sea-waves is no doubt to be sought in some displacement of the ocean-bed, not necessarily, however, of the rocky crust below. It is quite possible that they may have originated in the settlement through a yard or two of the loose superficial deposits at the bottom of the straits, such as are known to have taken place along its shores. Whatever the movements were, they were probably also responsible for the rupture of the telegraph and telephone cables which traverse the straits.

Causes of the Excessive Damage.— In 1891 an earthquake of great violence devastated the provinces of Mino and Owari in Japan. The intensity of the shock was four or five times as great as that of the Messina earthquake, and the area disturbed by it about ten times as large. Not far from the central area lies the city of Nagoya, with a population in 1891 of 165,000, where the intensity of the shock was slightly greater than that at Messina in 1908. Yet at Nagoya only 190 persons were killed by the Japanese earthquake. Taking the difference of population into account, the loss of life in Messina was thus about 430 times as great as that at Nagoya. In other words, if we take the Japanese city as a standard, about 998 out of every 1000 victims at Messina lost their lives through the bad construction of the houses in which they lived.

Among the destructive causes over which we have no control must be mentioned the early hour at which the earthquake occurred, when the great majority of the

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inhabitants were still asleep, and the entire absence of any warning shocks in the central district. But there are others for which the Italian Government and people, and especially the architects and builders, are, by their negligence, directly responsible.

First among these Dr. Baratta notes the fact that much of the damage wrought by previous earthquakes, and especially those of 1894, 1905, and 1907, had never been efficiently repaired.

Again, much also depended on the nature of the foundations on which the houses were built. It has been proved over and over again in great earthquakes that houses on a loose sandy foundation run a far greater risk than those erected on hard compact rock; even lofty houses on the latter foundation often escape without serious injury.

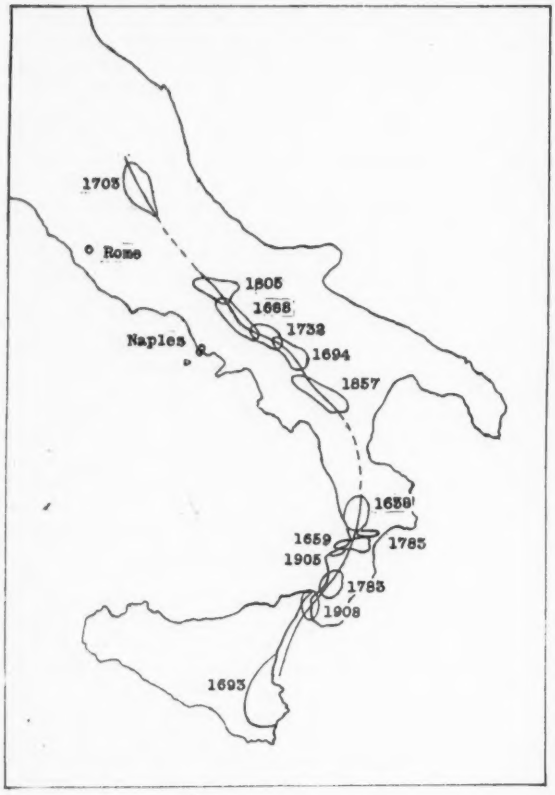


Fig. 3.

But, as already indicated more than once in this paper, the great cause of the damage, far excelling all others in importance, is the systematic defiance of the elementary principles of construction in earthquake countries—the use of the most wretched materials, the erection of heavy floors and roofs imperfectly connected with the main walls, and the construction of narrow streets, which became blocked by the *débris* of the ruined houses.

Relations with other Calabrian Earthquakes.—Notwithstanding the great total loss of life, the Messina earthquake does not by any means hold the premier place among the earthquakes of Southern Italy. The first great shock of 1783 had a far higher intensity, and gave rise to permanent changes in the ground over a much wider area than in 1908. Although it occurred at midday, the mortality (though not the total loss of life) was even greater than at Reggio and Messina, a maximum of 77 per cent. of the inhabitants having perished at Terranova.

In a study of the Calabrian earthquakes, one cannot help being struck with the frequent recurrence of the name of the same town or village in the annals of disaster. The areas of very violent motion seldom, however, occupy the same positions. In Fig. 3, which is reproduced from one of Prof. Omori's maps, the curves represent the boundaries of such areas for thirteen great earthquakes in Central and Southern Italy, the first of the series having occurred in 1638. They are arranged in three groups, but together they probably form one continuous seismic zone, extending from Central Italy, through Calabria, to the neighbourhood of Catania. As Prof. Omori remarks, this map "illustrates very clearly the principle that *great earthquakes* in a given region occur, not everywhere at random, but along a definite line of weakness in the earth's crust, namely, a seismic zone. Further, areas of violent motion of the different earthquakes are almost perfectly exclusive of each other, whence it may be concluded that the great disturbances are not repeated from one and the same centre, but happen successively from different points or portions along the seismic zone. In other words, the places seismically most dangerous in Central and Southern Italy are exactly those points along the seismic zone here defined which have not yet been visited by a very violent shock. The two cities of Messina and Reggio-Calabria, which formerly had not been shaken by a great telluric convulsion originating from a centre close by, had evidently their turn on the present occasion, and for that very reason may be supposed as being free from the danger of a future seismic catastrophe. Even in the case of a great earthquake occurring along the seismic zone, the intensity of motion at these two cities would, on account of the distance from the centre, not be so very strong, and a certain precaution taken in the construction of houses would be sufficient to prevent the loss of life and property."

The Sign of the Cross.

IN common with other universal symbols the cross emblem presents four clearly marked stages in its development, a simple idea, elaboration, sanctity, and decadence. The crux ansata of Egypt, which was originally a water gauge beginning with a simple stick set upright on the banks of the Nile to indicate the height of the annual overflow, was elaborated, first, by the addition of a short horizontal bar, thus forming a tau-cross, the masculine symbol sacred in Phœnicia to Tammuz, and later by the sun-circle, finally changed to a loop, making the object a handled cross. Thus juxtaposed, the fertility of sun and waters suggest the generative powers of Nature. This symbol appears in the catacombs with the sun circle transformed into a laurel wreath, expressive of the triumphant faith and hope of Christians. The first historical appearance of the swastika, fourteenth (?) century B.C., is apparently on a small leaden figure three and a half inches long, found by Dr. Schliemann in the second city of the ruins of Troy together with many crosses of gold, silver, etc., the location of the symbol on the figure having generative significance. The swastika indicated the sun—the feet referring to the rays, then fire and finally life.

MR. ROOSEVELT'S African hunting trip will result in enlarging the Smithsonian collection by 6,663 skins. The collection consists of hides of 243 large mammals, 1,500 small mammals, and 1,356 stuffed birds. Human skulls picked up along the line of the ancient slave trail are also included.

Blood and Its Relation to Disease.

By C. E. LEA, M.D.

THIS paper is intended to convey a brief, but I hope lucid, survey of our present knowledge of the blood. It is especially my desire to trace the sequence of discoveries leading up to such knowledge.

It may be said that it was not until two hundred years after Harvey's discovery of the circulation of the blood, namely, the beginning of the nineteenth century, that our scientific acquaintance with the blood was begun with the invention and gradual perfection of the microscope. To the work leading up to the construction of this instrument it is outside the purport of this paper to refer, but there is something of the fitness of things in the fact that much of the perfecting of this microscope was due to the patient labours of a certain Mr. Lister, and that, largely through its means, it fell to the lot of his son, the present Lord Lister, to revolutionise surgery and to become what has been aptly called "the greatest benefactor to mankind."

The microscope shows the blood (and I refer throughout to human blood) to be composed of two elements—*solid* cells or corpuscles of two varieties, called red and white corpuscles, floating in a *fluid* medium, called the blood serum. So that this paper falls, naturally, under three heads—discoveries relating to (1) red corpuscles; (2) white corpuscles; (3) the blood serum. And, conveniently enough for our purpose, it is largely in this order that the discoveries relating to each have been made. Thus, most of what we know about the red corpuscles was found out before research revealed the great importance of the less numerous white corpuscles; and similarly our knowledge of the white corpuscles was fairly complete before attention was, and still continues to be, directed to the last of the three elements, the serum. The reason of this sequence will be more obvious after a glance at the accompanying diagram (Fig. 1). This is a microscopic view of the blood circulating through the small capillary vessels in the web of a living frog's foot, a region chosen on account of the transparency of the tissues. It is a common "biological exhibit." It may be seen at many college soirées and is usually a successful means of duly impressing upon credulous aunts and admiring sisters the profound scientific knowledge of the first year medical. But this view is of more than passing interest in that here we have the identical picture of the actual circulating blood as first seen by the pioneers of histological research. One sees the red corpuscles crowding and jostling one another along the narrow vessels, like children running along a street. So numerous are these red corpuscles that it is with difficulty that one can occasionally catch a glimpse of the white corpuscles (W). These two varieties of corpuscles show striking differences. The reds vastly outnumber the whites (500 to 1). The reds are uniformly circular or disc-shaped and their pale yellow colour renders them distinct by contrast with the colourless serum; the whites are irregular in shape, changing their form frequently

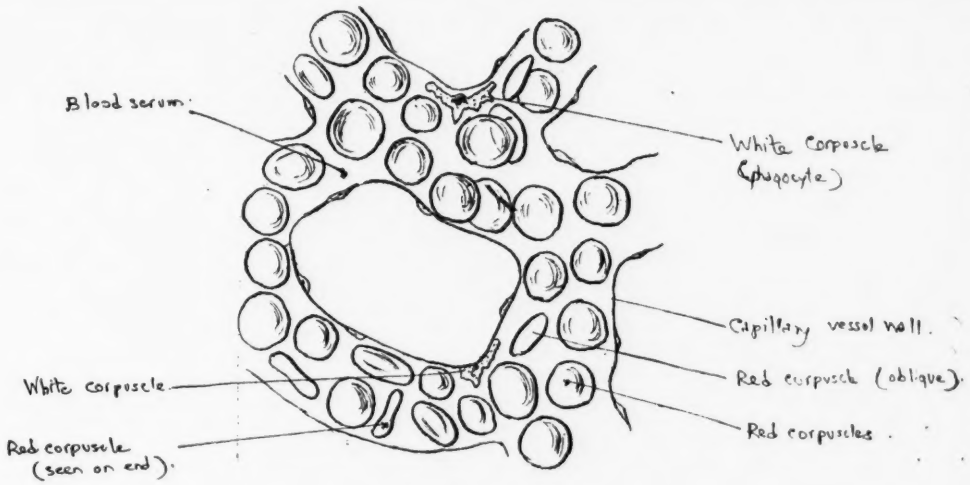


Fig. 1.

BLOOD CIRCULATING IN CAPILLARIES FROG'S WEB (SEMI DIAGRAMMATIC)

to adapt themselves to their environment, and they are colourless. The reds are relatively stable in texture

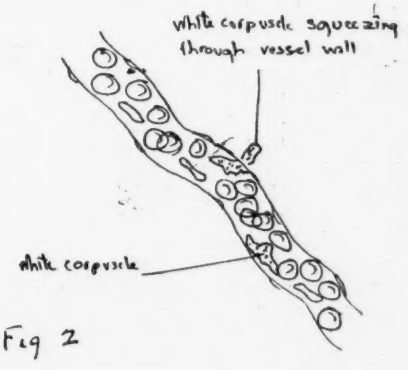


Fig 2

and dominate the centre of the slow-moving blood-stream; the whites are delicate and fragile and, forced

against the vessel-wall by the reds, amble much more slowly along and, as in Fig. 2, may even be pushed through the vessel-wall (this is an important fact as will be seen later).

Such differences in character between the red and white corpuscles might have suggested equally marked differences in function, but, as is so often the case in other spheres, the more demonstrable elements, namely, the reds, monopolised attention, to the exclusion, for a season, of all research upon their more insignificant neighbours, the whites.

FUNCTION OF RED CORPUSCLES.

The solution of one of the oldest questions asked about the blood, namely, why is the blood red? was found in the discovery that the colouring matter of the blood was situated exclusively in the red corpuscles. This colouring matter is called hæmoglobin. It is a highly complex, unstable, iron-containing proteid. Its most interesting property is this: that it possesses a marked capacity, in an oxygen-holding environment, of absorbing this oxygen chemically, and an equally marked capacity for giving it up again in an oxygen-less environment. Now, the value of this property will be obvious when we consider the circulation of the blood. When the blood passes through the lungs it is in practical contact with the oxygen-containing air, so the hæmoglobin in the red cells absorbs this oxygen. The oxygenated blood then passes from the lungs to the tissues of the body, and here comes in contact with relatively oxygen-less tissues—muscles, for instance, muscles which, perhaps, have been exhausted by exercise and have thus accumulated in their substance waste, effete products. What happens? The red cells give up their oxygen at once, the hæmoglobin is reduced, but takes up, instead of oxygen, carbon dioxide from the tissues, which are thereby regenerated, and the carbon dioxide is thus conveyed away by the red corpuscles to the lungs, where it is given up in the expired air. The value of the red corpuscles to the body corporate is obvious. They are the oxygen-carriers. Here is the reason for the crush and bustle of these tiny red corpuscles one sees in the vessels. Each corpuscle conveying its precious freight of revivifying oxygen is hurrying to its destination, either giving up its load where most required or dashing back to the lungs to get a fresh supply for the ever hungering tissues. Here, too, we see the reason why they should be so numerous and how their shape and consistence are so admirably adapted for their purpose. They must be small enough to get along the smallest vessels to the most distant organs and tissues, and for this purpose their semi-elastic structure and their circular shape are just the things; they must be numerous enough, too, to supply the never-ceasing needs of the tissues for oxygen and to make up in numbers their deficiencies in size. Truly a herculean task. But how efficiently performed. The body's dependence on oxygen and, consequently, these little carriers may be strikingly seen in two instances.

(1) It is an interesting fact that there is a permanently increased number of red corpuscles in the blood of people living in rarefied air, *i.e.*, high altitudes and relatively less oxygen, when compared to people living under what we call normal conditions. Compensation for diminished relative quantity of oxygen in rarefied air is thus established. So that, whereas it is estimated that normally one has about five million red corpuscles to the cubic millimetre, in these people there may be six or even seven million reds in the same area.

(2) No death is so sudden or so sure as that following exposure to fire-damp or coal-gas. Death here is due to suffocation brought about by the carbon monoxide (the toxic element) combining with the hæmoglobin of the red cells to the exclusion of the vital oxygen. The rapidity with which the fatal end occurs is marked evidence of the speed and efficiency with which the red cells convey their freights, in this case the poisonous gas, through the system.

Most scientific facts have a practical bearing. In forensic medicine the peculiarly specific qualities of the hæmoglobin allow of the most delicate and sure tests for its presence being detected in the minutest quantities. In three ways can blood be detected. (1) Microscopical examination. The shape and size of the red cells indicate the animal from which the bloodstain has been derived, different animals having different-shaped corpuscles. (2) Chemical tests. (3) The spectrum, the characteristic lines produced by hæmoglobin being very conclusive evidence.

In the presence of most diseases the red corpuscles fortunately preserve a stolid indifference. Neither in number nor in quality do they vary much, even in the acutest diseases. Only in certain forms of anæmia is their number diminished to any appreciable extent, and here the administration of iron—as we have seen, a necessary component of hæmoglobin—is usually an effective remedy. The relation of the reds to certain parasitic tropical diseases will be referred to later.

Now for the white corpuscles. Their significance remained unsuspected until the researches of Lord Lister in this country, Koch and many others abroad, proved the disease-producing capacities of germs, and until Professor Elie Metchnikoff, of the Pasteur Institute, showed that it was the white corpuscles which, by their power of attacking and by ingesting destroying bacteria, were our chief protective agents against these germs. With the dawn of bacteriology and the discovery of the means and channels by which bacteria gain entrance into the tissues to destroy or be destroyed by the body's protective mechanisms, came the far-reaching discovery that the advanced line of defence was undertaken chiefly by these meandering, amorphous, hitherto apparently useless, white corpuscles.

How essential for the continuance of life are the phagocytes, as the white corpuscles are now called, and how frequently their protective functions are called upon are facts obvious when one thinks how often the frail human body is attacked by the ubiquitous germs, whether in the form of "inflammation"—a process essentially bacterial in origin—or in the more subtle guise of fevers, all of which, too, are bacterial.

Now, inflammation, either in the form of abscess or in the more serious form known as "blood poisoning," is typical enough of all forms of bacterial invasion for the purpose I have in mind, which is to picture as clearly as possible (1) the manner of attack of the bacteria; (2) the manner of resistance to the attack; and (3) the important part played by the phagocytes amongst the body's opposing forces.

It is a battle royal. The first duty of an intelligent war correspondent is to cable home an approximately accurate account of the strength and dispositions of the opposing forces and the character of the ground over which the action will be fought. Only by so doing can the breakfast table at home follow intelligently the phases of the struggle. So in the battle one is attempting to outline a similar plan will be

followed. The opposing forces are (1) bacteria; (2) protective body mechanisms.

The site of battle, the human body, say the finger. The opening phase of the battle, a scratch of the finger by a rusty nail, whereby the bacteria gained entrance through the first line of defence, namely, the skin, into the tissues. The means of attack are different in the opposing armies. These weapons are :—

(1) Bacteria. (*a*) Minute size whereby they have great penetrative power; (*b*) enormous powers of multiplication, *i.e.*, great recruiting powers; (*c*) powers of excreting toxines or poisonous fluids which may kill white corpuscles or destroy tissues locally.

(2) Body Protective Mechanisms. (*a*) White corpuscles or phagocytes capable of ingesting and destroying bacteria in large numbers, being many times larger and possessed of great mobility or skirmishing capacity (note their power of passing through vessel-walls); (*b*) recruiting centres for fresh phagocytes situated in the glands nearest site of infection (*e.g.*, finger-glands in armpit); (*c*) extensive lines of communication, blood-vessels and lymphatics—channels for the passage to the front of recruited phagocytes and commissariat, *i.e.*, increased blood supply. So much for the main characters of the opposing forces. What happens (*a*) when an abscess forms at the finger or (*b*) when this septic wound goes on to blood-poisoning?

Everyone knows the symptoms produced by a "festering" finger.

(1) Pain. No pitched battle between germs and tissues can take place without setting up pain in the part due to pressure upon the fine nerve-endings and the increased tightness of the skin caused by

(2) Swelling. This is due to thousands of phagocytes which have been hurried to the spot to attack the bacteria. They reach the spot along the blood-vessels, through the numerous lymphatic channels, and often squeeze through these vessel-walls into the tissues themselves.

(3) Redness. The skin is red because of the dilated blood-vessels, vessels widened to allow of more blood being brought to the part, and, incidentally, more phagocytes.

(4) Heat is produced for the same reason.

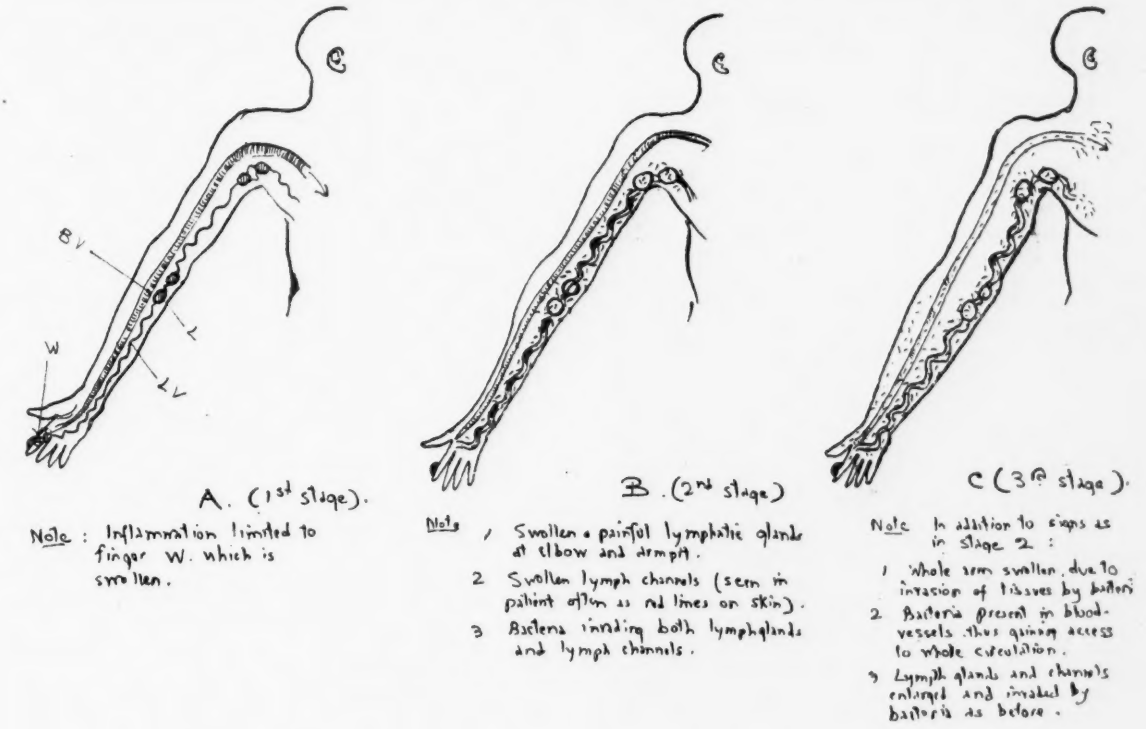

BV
L
W
LY
A. (1st stage).
Note : Inflammation limited to finger W. which is swollen.
B. (2nd stage)
Note 1 Swollen & painful lymphatic glands at elbow and armpit.
2 Swollen lymph channels (seen in patient often as red lines on skin).
3 Bacteria invading both lymphglands and lymph channels.
C (3rd stage).
Note In addition to steps as in stage 2 :
1 Whole arm swollen due to invasion of tissues by bacteria.
2 Bacteria present in blood-vessels thus gaining access to whole circulation.
3 Lymph glands and channels enlarged and invaded by bacteria as before.

Fig. 3. DIAGRAM OF THREE STAGES OF BACTERIAL INFECTION

BV = BLOODVESSEL L = LYMPHATIC GLAND LY = LYMPH CHANNELS.
W = SEAT OF INFECTION.

Varying degrees of these symptoms denote the opening stages of the battle. What follows? Two things may now happen.

(1) The abscess may "burst" or (the same thing for our purpose) be lanced by the surgeon. This allows relief of the tension on the parts and the expelling of the bacteria and the tissues destroyed by them. Healing subsequently follows. The battle is over and victory rests *cum corpore.*

(2) The bacteria may get into the system and cause all the alarming symptoms of blood-poisoning. These symptoms and their interpretation are as follows: (*a*) Enlarged and painful glands. These are caused by the superactivity of these structures in manufacturing thousands of fresh phagocytes. They are potent recruiting centres and at such times are liable to

become congested. But their intense activity may also be due to the bacteria themselves having invaded the glands, reaching them by forcing their way along the winding lymphatic canals or *viâ* the swifter-flowing veins. When the bacteria have thus burst upon the lines of communication the symptoms are much more serious. (*b*) Rise of temperature. (*c*) Increased pulse-frequency. (*d*) Nausea. All due to the entrance into and circulation through the blood-vessels of the germs, together with the powerful toxines which they can, under such conditions, excrete. This general invasion of the system by the bacteria constitutes what we know as blood-poisoning, and the final result of such cases depends ultimately on the resisting power of the individual, *i.e.*, the power his body has of manufacturing anti-toxines and phagocytes in sufficient number and within a limited period of time. The result of the battle when it has reached this stage is not infrequently in favour of the bacteria.

To recapitulate the phases of the brief campaign:

(1) Invasion of tissues by bacteria (in this case through a cut on finger).

(2) Multiplication of bacteria and rush of phagocytes to site of invasion, causing symptoms of pain, redness, swelling, etc.

(3) (*a*) Bursting of abscess with dispersion of bacteria, healing, or (*b*) further attack by bacteria on to lines of communications and on recruiting stations (glands under armpit). Finally (*c*) overpowering of phagocytes by bacteria due to invasion of whole body by bacteria (blood-poisoning), serious illness, or death.

In the preceding diagram these three possible phases are schematically shown (Fig. 3).

It was stated that the discovery of the causative importance of bacteria in relation to disease preceded in date that of the manner, briefly outlined above, in which the phagocytes resisted or re-acted to such invasion. Further, an increasing number of diseases have been shown to be bacterial in origin. It is, therefore, a natural question to ask whether the phagocytes respond in a similar manner in all cases, since bacteria differ considerably in character and potency in different diseases.

Put in a concrete form one may ask: Does this phagocytic theory apply equally to such different diseases as tuberculosis, diphtheria, and typhoid fever —all proved to be bacterial in origin? Within wide limits one may answer in the affirmative. One sees, therefore, why this theory has such a wide-spreading significance. The difference in symptoms in these diseases is due to two causes only—(1) the varying virulence and character of the bacteria; (2) the varying site or sites of attack. But the phagocytic method of attack in each case is identical.

Now for the last constituent of the blood—the serum. Despite the far-reaching application of our knowledge of the white corpuscles in combating disease, there yet were many curious facts concerning disease which still remained inexplicable on the phagocytosis theory. There were frequently met with extraordinary cases of natural immunity from disease; people who could enter a plague-stricken city and, whilst being in ceaseless contact with the disease and its victims, yet remained unharmed. Everyone is familiar, too, with the great variation amongst individuals in their liability to contract certain illnesses. The phagocytic theory afforded no explanation of these cases, nor yet of the powerful protective agency of vaccination, first applied against smallpox, and now extended in its application to diphtheria, typhoid, and many other diseases. Vaccination or injection of anti-toxin is a means whereby the blood can be rendered highly resistant to the attack of a particular germ. If phagocytosis were our only safeguard, then we should expect to find that this immunising result was obtained by a large increase in the number of white blood corpuscles. But this is not so. Nor are the red corpuscles in any apparent way altered in character. The change in the quality of the blood thus produced, with regard to its bactericidal properties, whereby the blood is rendered powerfully resistant, not only during an acute disease, but for long periods of time following vaccination, occurs in the blood serum. The blood serum is the powerful ally of the phagocytes, and since the mass of the serum in the body as compared to the mass of the phagocytes is in enormous preponderance, it follows that even the slightest change in the quality of the serum must have far more potent effects than could be expected from the phagocytes. It is the subtle change produced in the serum, not the phagocytes, by vaccination which renders vaccination so effective. It is the quality of the serum, not of the phagocytes, which finally settles whether a person shall overcome or succumb to a particular infection. The serum then appears, after all, to be the more potent factor in combating disease.

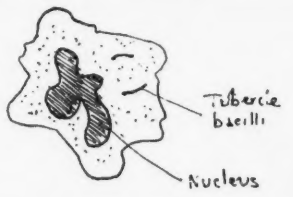


Fig. 4 White blood corpuscle ingesting Tubercle bacilli. (1 x 1000) Micro.

The question naturally arises, what is the relation of the serum to the phagocytes? According to our present knowledge this relationship may be stated briefly. When bacteria invade the body it is the serum which, by acting in some subtle way upon these germs, renders them capable of being destroyed with greater facility by the phagocytes. The serum is the sauce which makes the predatory phagocyte relish the bacteria. The serum is the appetiser, and it is upon this quality of this potent fluid that the final result of an infection must stand. It is the serum, then, that is the master of the situation, but just as a general without his soldiers is helpless, so the most powerful serum without the aid of the phagocytes to complete its bactericidal action would be useless. And so, if one is to judge the quality of a person's resisting power to disease, it is the character of his serum and not the number of his white blood corpuscles which gives us the index. Only within the last few years, thanks largely to the brilliant researches of Sir Almroth Wright and others, has a method been devised by which this quality of the serum can be estimated. This measurement of resisting power to disease is termed the *opsonic index*.

The technique of this estimation is rather elaborate, but the principles on which it is carried out may be easily understood. The four factors are: (1) patient's serum; (2) normal serum; (3) phagocytes; (4) bacteria. The opsonic index is the relation between the number of bacteria devoured by phagocytes in a given time by

a normal person and the number devoured in a similar time by the patient. Supposing 25 bacteria were devoured by 20 phagocytes in 15 minutes by a normal person and only 20 bacteria were destroyed in a similar time and by a similar number of phagocytes by a patient. The patient's opsonic index would be $\frac{20}{25}$ or .8. This difference in the avidity of the phagocytes in the two cases is due to difference in potency of the activating blood serum, and in this way one can obtain a very accurate clinical picture of the blood condition during a particular infection.

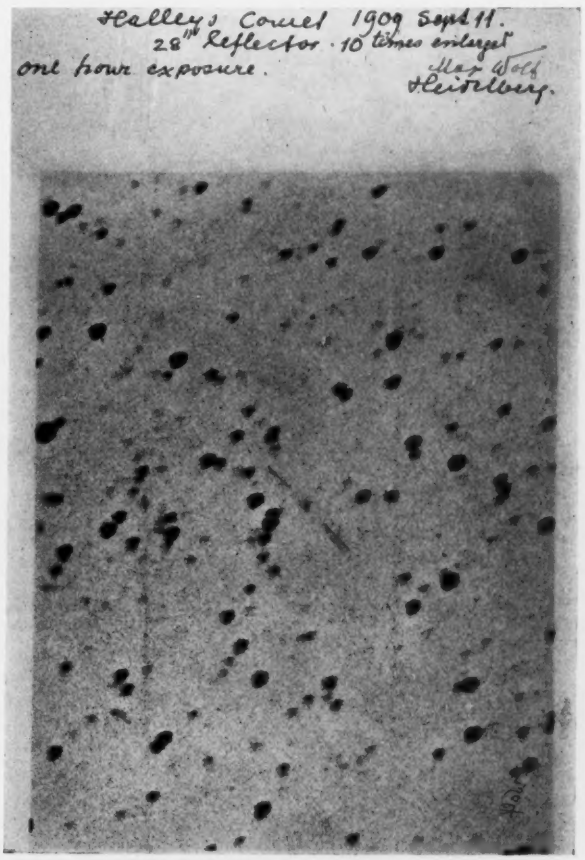
It is easy to see now how the explanation of natural immunity or the results of vaccination was not to be found by merely counting the number of phagocytes. These are the active agents of destruction employed against the bacteria, wonderfully efficient agents too, but still only agents. It is in the controlling director, the serum in which the phagocytic agents swim, that the explanation of the phenomena of immunity is to be found.

Lastly, it may be seen how we have, by this opsonic technique, an accurate clinical means of gauging the strength of the blood in its power to resist a particular disease. A record of the opsonic index of a patient's blood may be kept and observed with as sure an accuracy as the pulse can be counted. And in these days when successful vaccination against an increasing number of diseases is proving the efficiency of this vaccine therapy, it is more than ever necessary that we should have a means not only of gauging the condition of the blood before we attempt by vaccination to alter its resisting power, but also of estimating the effects of such vaccine dosages, thereby enabling correct quantities of the vaccine being given at correct times. This is the vaccine therapy, for which we are largely indebted firstly, to the original discoverers of the germ causation of disease; secondly, to Metchnikoff for his discovery of the bactericidal properties of the white corpuscles; and lastly, to Ehrlich in Germany and Sir Almroth Wright in our own country, who have shown the active protective functions carried on by the blood serum, the means by which such functions can be practically measured, and, by the employment of suitable vaccines, regulated.

This paper would not be complete without noting the way the pendulum of blood research has again swung back to the red corpuscles. This has naturally followed from the extraordinary discoveries recently made in tropical diseases. In many of these scourges, such as malaria, sleeping sickness, and probably yellow fever, the causative germ is situated, not in the tissues as in ordinary inflammation, nor in the serum as in the intoxications of fever; the germ is located in the red corpuscle itself. Inside the small red corpuscles the *Plasmodium malariæ* thrives, and reproduces its kind. Similarly the *Trypanosome gambiensi*, the germ of sleeping sickness, screens itself from any possible phagocytic action of the white corpuscles by ensconcing itself within the relatively thick cell-walls of the red corpuscle. Phagocytosis here is useless. No white corpuscles are powerful enough to attack these germs, which are not only inside the red cells, but are many times larger than the largest bacteria, and though not capable of so rapid multiplication as the bacteria, are possessed of much longer lives. Vaccine therapy has so far proved of no avail, and though in the case of malaria the fortunate discovery of the specific curative effects of quinine has enabled us to successfully treat this disease, nothing has so far been found to be of any avail in curing sleeping sickness, a scourge which threatens to depopulate the whole native population of Equatorial Africa. These diseases, proved in most instances to be conveyed by insect life, are wholly different in clinical character from the bacterial diseases we are so familiar with in this country. They necessitate correspondingly different lines of treatment. We are not without hope that a cure will be found in the near future. The fate of Empires may hang on the issue. Undertakings of world importance, such as the construction of the Panama Canal, proved unsurmountable until the cause of malaria was shown to be due to the mosquito and its prevention in the Panama malaria-stricken isthmus thus brought about. With the quiet laboratory work of the hæmatologist rests some of the credit, but without the aid of every other branch of science his work could not have been wrought. In science, above all things, does this motto hold the great truth " Unity is Strength."

Halley's Comet.

THROUGH the kindness of Mrs. Periam Hawkins, whose admirable illustrated booklet on Halley's Comet has already received notice in our columns, we have received a print of the first photograph which was made of



Halley's Comet on its reappearance last year. The photograph was made by Professor Max Wolf at Heidelberg, from whom Mrs. Periam Hawkins received it. The comet is, of course, too small an object in any way to obscure any of the stars shining behind it: but even were its tail developed the stars would be seen through it.

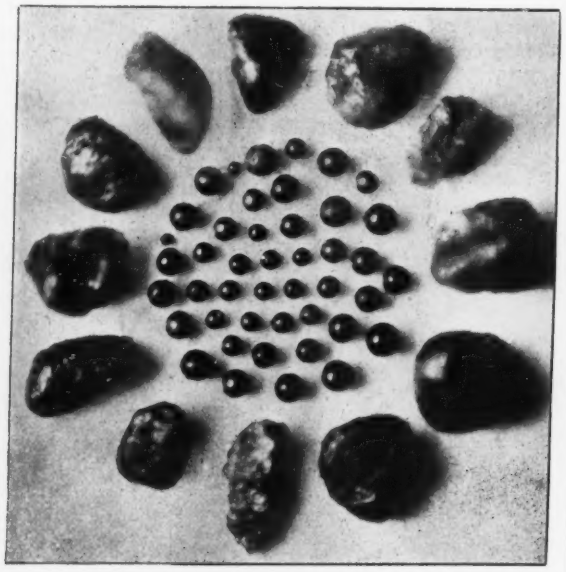
XUM

Meteoric Dust.

By F. T. AMAN, Assoc.M.Inst.C.E.

THE group of shot-like pellets arranged in the middle of the illustration are minute hollow spheres of steel known as meteoric dust; they are infinitely finer than grains of sand, a few of which have been placed around the group for the purpose of showing their comparative size. The whole is magnified 1200 times or 35 diameters, and could be placed inside a circle one-tenth of an inch in diameter.

Their origin is interesting. Meteors or shooting stars, as they are more generally called, have, from the beginning of things, been bombarding the world at a rate estimated by the highest authority at many thousands an hour, of which, however, an average of only five or six are visible to the naked eye during the same period of time. Fortunately, owing to our protecting envelope of air, very few of these missiles reach us. In size meteors



Meteoric dust, and grains of ordinary sea shore sand.

vary from a few ounces to many pounds in weight, and it is only very occasionally that one is of sufficient dimensions to survive the passage of 80 to 100 miles through an atmosphere increasing in density as the earth is approached.

The speed at which they enter the atmosphere, calculated at not less than 35 miles a second, generates such intense heat by friction that the iron of which the meteor principally consists is immediately reduced to an incandescent vapour, which is the luminous train so frequently seen in the heavens on a clear night. The vapour rapidly cools and condenses in the form of these minute particles, which assume the spherical form as does shot during its fall from the top of the tower. Finally, the little spheres are scattered by the winds and currents in the upper regions and gradually descend in their millions as an invisible, but never ending, shower.

The perfect condition in which the spheres are found is due to the presence of certain non-corrosive elements found by analysis to be present in the metal of meteors which have come to earth.

These little spheres will be found in almost any sample of dust, particularly where such has collected in sheltered recesses or hollows, as in the gutter on the housetop, or round the roots of old trees and dry ditches. They may be readily gathered by a magnet, and when mounted form an interesting object for the microscope.

Electric Power Transmission.

ONE of the electrical problems of the future is the successful transmission of electric power over long distances. For many reasons, of which economy is one of the chief, electrical power is best transmitted at high voltages, and these high voltages are most conveniently carried by overhead lines. When high voltages are used, however, the transmission lines and the electrical plant as a whole are subject to what, if we were speaking of the transmission of heat, we should call sudden rises of temperature. These "resonance surges," as electricians speak of them, occur in underground lines, as well as in overhead lines (where they may be caused by atmospheric disturbances, more common in countries where thunderstorms are frequent, but present in all localities), and devices for lessening the danger of them are a necessity of electrical practice.

Two such devices are now available, and are described in the new pamphlet which is issued by Messrs. Isenthal and Co., of 85, Mortimer Street, who have acquired the patent rights for the "Moscicki Condensers" and "Electric Valves." The condensers, which owe their name to Professor Moscicki, resemble extremely long and very effectively insulated Leyden jars, mounted in tin or brass tubes; and when used for electric line protection are mounted in numbers on a wrought-iron frame. Their inner coatings are connected in parallel through high tension fuses to a common terminal, to which the line is connected. The outer coatings are connected to the outer tin or brass tubes, and earthed by means of the framework.

The Electric Valve consists of a number of spark gaps designed in the form of flat discs, so arranged that they present a certain capacity to earth and to each other. The first spark gap, however, is in the ordinary form with two spherical terminations, and between it and the first disc spark gap is interposed a metallic high resistance. It is claimed that this peculiar capacity arrangement entirely avoids the formation of high-frequency oscillations when the valve acts, and yet permits of dealing with considerable quantities of energy by placing a number of such individual spark gap columns in parallel.

Photographs of the Moon.

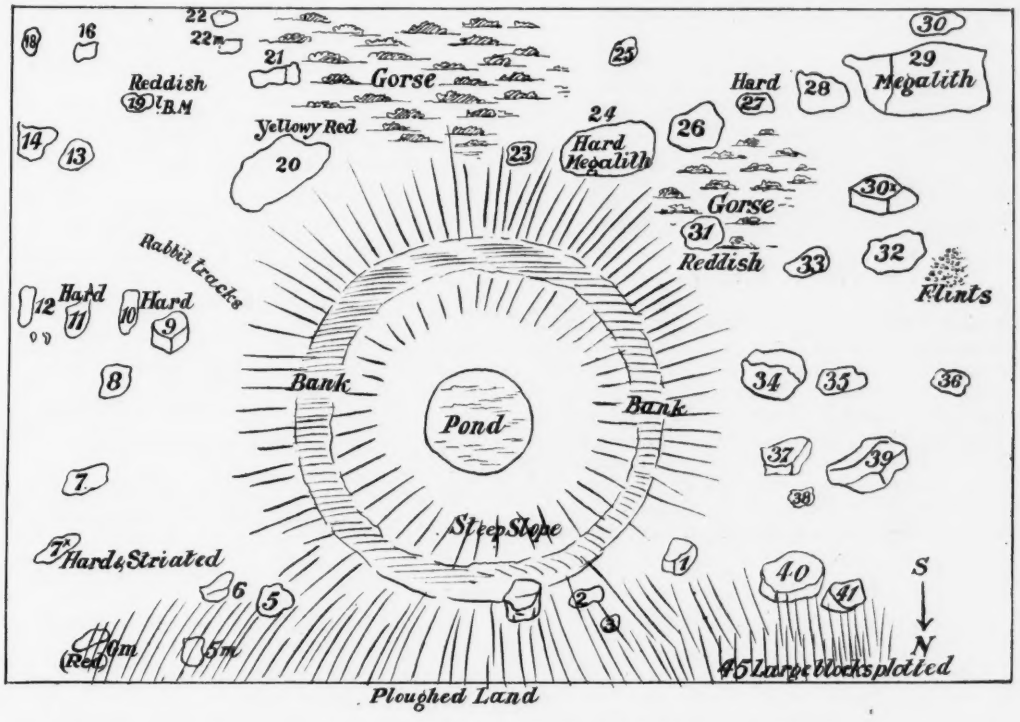
SEVERAL readers have asked for an explanation as to how the Plates which we have recently published can be joined together to form a large representation of the moon. It is necessary to explain that no large photograph of the *full moon* would satisfactorily show the details of the mountains and depressions. These are only rendered clearly visible when the sun illuminates one side. Therefore a number of photographs taken at different phases of the moon is necessary to show all the details well. If all these views were joined together it would be found that some of them were illuminated from the right and some from the left. Each quarter is, however, distinct. Thus, Part I. fits on to the right of Part III., while Part II. fits on below, connecting both together, the three forming the first quarter of the moon (the lower right-hand corner as you look at it). In the same way Parts IV., V., and VI., form the second quarter, and so on. Many of the Plates, of course, overlap, so that the same object may be seen on adjoining Plates.

Megaliths on the South Downs.

By EDWARD A. MARTIN, F.G.S.

WHILST engaged recently in surveying some dew-ponds on the Sussex Downs I had reason to visit on several occasions a remarkable pond lying to the north of Standean, which is so far out of the ordinary as to deserve some special comment. Unlike most of the downland ponds, which consist of a comparatively shallow trough depressed not more than about 6 feet below the level of the surrounding bank, the one under consideration resembles a deep crater, as one might call it, the centre of the pond being fully 12 feet below the top of the surrounding bank. One cannot but speculate as to the causes which gave rise to the necessity of excavating to this pond and bank is oblong in shape, and is itself surrounded by cultivated fields.

What is most remarkable concerning the pond, however, is that the oblong piece of uncultivated ground outside the bank is strewed with enormous boulders. In the plan I have endeavoured to show how these are placed. The weight of some of these must be enormous, and three at least of them deserve the name of megaliths. Scattered about on the Downs around are one or two similar boulders, isolated from one another, but why should so many of them have been brought together in one place? I think it reasonable to suppose that they have been brought thither by human agency. I am very doubtful if they have been brought there merely with the object of clearing the land for the plough. It is impossible to conceive that it would have paid a farmer to bring them all together for this purpose, and I am



depth. If the only reason were merely that of making a pond this could have been obtained by a much shallower excavation, and we now know it is a very difficult matter to keep full a pond exceeding 3 feet in the centre, owing to the heat of the earth always tending to keep, by evaporation, the water at about that level.

The existing pond, as a matter of fact, fills but a very small proportion of the area enclosed, as will be seen by the accompanying sketch, the diameter of the pond being 26 feet, and the edge of the pond being 20 feet from the top of the bank. Around it and within the high banks wild flowers and grasses grow luxuriantly, and if the object of excavation were merely to make an enormous pond, the result has been a great failure.

The material thrown out has been utilised to form a bank on the east, south, and west sides, that on the south giving the greatest drop on the outside, whilst the top of the north bank is level with a ploughed field. The unploughed portion of land which surrounds the bound to fall back on the theory that they are the relics of a great circle or series of circles, which may have had an origin in the rites and ceremonies of some ancient form of religion similar to the uncontroverted religious origin of our more famous Druidic or other circles.

I am aware there are difficulties in this theory to be faced. The arrangement of the stones does not give much resemblance to a circle. It is rather one of straight parallel lines, and there is a suggestion about them of avenues leading to a central spot. It seems strange that the evidence which they afford has not before received attention from archæologists. The South Downs are remarkably free from evidences of the religion of pre-Roman races, and it may be that here we have what many have been so long searching for. Near at hand on the northern escarpment there are mounds innumerable which may be barrows, some of which bear evidence of having been excavated in search possibly of treasure, but these are easily noticeable, and are seen by hundreds

of passers-by every year. This pond and its surroundings are quite off the beaten track, and the pond even would escape one's notice without the aid of the Ordnance map. The pond is a few paces north of the 600 ft. contour line, and on the east the ground falls away to the dry valley known as Dencher Bottom, which leads by way of Patcham to the Brighton valley.

Altogether there are 45 principal boulders. Of these the largest dimensions of two at the south-west corner were $7\frac{1}{2}$ ft. by $4\frac{1}{4}$ ft. and $6\frac{1}{2}$ ft. by $4\frac{3}{4}$ ft.

Large block (29) at S.W. corner.

As regards the material of the stones, this is as a rule a grey siliceous stone, much like a quartzite, and in some cases the stone is so hard as to withstand scratching with a steel knife. A few are of a red sandstone, with small nuts of hard chalk or flint mingled in it. Probably all are relics of the tertiary beds which at one time covered the chalk, the softer portions of which have been denuded away in the course of ages. On one of them, marked No. 19 on the sketch, there are the remains to be seen of what may have been an old bench-mark, but this cannot be alleged with certainty.

Solar Disturbances During December, 1909.

By FRANK C. DENNETT.

DURING December meteorological conditions proved very unfavourable for astronomical observations. There appears to be a marked falling off in the number of disturbances as compared with the months directly preceding, although at least two of the spots attained considerable magnitude. The longitude of the central meridian at noon on 1st was 120° 28′.

Nos. 132, 133, 134, 135, 135*a*, 136, 137, and 138 are repeated from the November chart as they still continued on the disc during the early days of December.

No. 137*a*.—A spot developed in front of No. 137, first seen 3rd, pores being scattered between the two. Visible until 8th. Nos. 137*a*, 137, and 138 together made a line of continuous disturbance over 160,000 miles in length.

No. 139.—A group well on disc on 14th; the leader attained a diameter of 30,000 miles, and the length of the outbreak reached 66,000. It died down so that when last seen, on 24th, only the leader remained.

No. 140.—On 18th and 19th a group of three pores, two spotlets only on 20th and 21st, one on each date appearing double. Only facula at the area on 24th.

No. 141.—A considerable spotlet seen 18th-21st.

No. 142.—A spot 10,000 miles in diameter, but somewhat variable, apparently a return of No. 132, seen 18th-29th. On 24th the edge of the penumbra around the umbra was bright fringed.

No. 143.—A spot 16,000 miles in diameter, seemingly a return of No. 133, visible 18th-30th. The inner edge of its penumbra bright fringed 24th.

No. 144.—A spot 22,000 miles across on the site of No. 134, solitary, except on 24th, when a pore appeared directly south. On the same date also the inner edge of its penumbra was bright fringed. Seen 19th to 31st. Both at eastern and western limbs a bright faculic streak stretched a long way north-eastward from this spot.

No. 145.—The large spot 16,000 miles across with pores south-east 24th and 25th, others south and south-west on 29th. The inner edge of the penumbra was bright fringed 24th. Visible 24th till January 3rd.

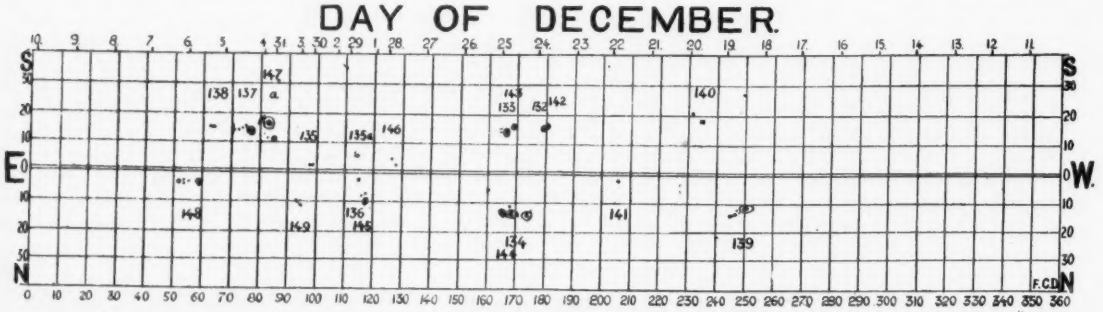
No. 146.—Two minute pores only seen on 24th and 25th.

No. 147.—A large spot 30,000 miles in diameter on 25th where its advent had been indicated previously by bright faculæ. Several pores visible both north and south-eastward on 29th, some few remaining until January 2nd. Last seen 5th.

No. 148.—A spot 14,000 miles in diameter with pores east, south-east, and north-east for 71,000 miles. First seen 29th; it must have remained visible until January 8th, but the last observation which has come in is dated 3rd.

No. 149.—Two pores seen 30th and 31st, one lingering until January 2nd.

Our chart has been constructed from the observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, and F. C. Dennett.



The Duration of the Neolithic Age in Britain.

By W. A. DUTT.

ALTHOUGH the belief that because the Neolithic or Later Stone Age implements of Britain are chiefly found in surface deposits or on the surface of the ground little or nothing can be determined as to the relative chronology of different specimens has hitherto been passively accepted by the majority of archæologists, a few students of prehistoric problems have had their doubts as to whether the interests of science would not be better served if field-workers, instead of taking so much for granted, would strive to discover fresh methods of dealing with such problems, in the hope that thereby fresh light might be thrown upon them. Denied the aid of the geologist, who often works hand in hand with the archæological delver into Palæolithic clays and gravels, the student of the Neolithic Age must find in its implements themselves the keys to the various puzzles they present, and although it would be rash to assert that all their secrets are solvable, one seems justified in believing that in course of time the term Neolithic—which has so well served its original purpose—if not abandoned, will be understood to signify not so much a stage of culture as various stages of culture, each represented by more or less clearly distinguishable implements. Good work, tending towards this end, is already being done, and more than one classification of Neoliths according to their respective ages have been tentatively suggested, notably by Messrs. M. A. C. Hinton and A. S. Kennard* and by Mr. W. G. Clarke,† while Dr. W. Allen Sturge, in his Presidential Address to the Prehistoric Society of East Anglia,‡ has enunciated a startling theory, the acceptance of which will necessitate the co-operation of geologist and archæologist in elucidating Neolithic problems. A detailed statement of Dr. Sturge's views will, I believe, be printed in the course of a few months, and should be a welcome stimulus to those archæologists who have been trying to make some headway despite the *nolle prosequi* attitude of so many of their contemporaries.

Some time ago, I drew attention in "KNOWLEDGE" § to a series of rather rudely worked, dull, unpatinated flint implements which I had discovered on certain Romano-British sites, and which, in my opinion, were of Romano-British date. In the article in which I described them I gave my reasons for believing that they could be distinguished from prehistoric Neoliths, and archæologists who have gone into the matter have satisfied themselves that the evidence is in favour of my theory. Since that article appeared, I have done a good deal of archæological field work, one of the results of which has been a strengthening of my conviction that a careful examination of a large number of surface flint implements must make it clear to any unbiassed person that not only is it possible to distinguish worked flints which are probably Romano-British, but also that a considerable number of prehistoric Neoliths may be separated into certain groups, each representing a different age. One of these groups —a very marked one—has already been described by Messrs. Hinton and Kennard, who call it the Cissbury group. It chiefly consists of large roughly worked implements, always white and well weathered. In the South of England they occur in isolated patches on the chalk hills, and this is also the case at Weeting, Massingham, and Ringland, in Norfolk. Most of them show signs of having been fashioned out of nodules of excavated flint, and in this connection it should be noted that at Cissbury, Weeting, and Massingham prehistoric flint-workings or quarries have been discovered. Excavation would probably prove that traces of such old workings exist on or near all the sites where white Cissbury implements are plentiful.

To the believer in the possibility of recognising implements of different ages among our surface worked flints, these large white Neoliths are especially instructive. Anyone who has the chance of handling a hundred or so of them can generally pick out, without much difficulty, half a dozen or more pieces which have been re-worked by man at some period very much later than that during which they were originally shaped into weapons or tools. Such re-worked implements were noted by Messrs. Hinton and Kennard, who have pointed out that the later chipping always shows up black against the white surface of the original tools; but this alone does not convey a clear idea of the great antiquity of the Cissbury group. In the first place, it must be remembered that these are implements made out of excavated flint, and that when they were made they were as black as the interior of the nodules from which they were fashioned. After being in use, they were left lying on or near the surface of the ground long enough for their surface to weather from black to white before some comparatively late stone-worker came along and re-chipped them. Now, as the work of the re-chipper still shows up black against the white of the earlier worked surface it must be admitted that a far longer period elapsed between the time of the first making of the implement and that of its being re-worked than has elapsed between the time of its re-working and to-day. Mr. Clarke, who has made a special study of the Weeting and Ringland flints belonging to the Cissbury group, states that 40 per cent. of the Ringland implements appear to have been re-chipped. From these re-worked Neoliths, therefore, we are able to gain some idea of the long duration of the Neolithic period.

Re-chipping, however, is by no means confined to implements of the Cissbury group. From the wide heaths and large open sandy fields of the East Anglian Breck district hundreds of thousands of well-worked Neoliths have been obtained, certainly representing more than one stage, and in all probability several stages of Neolithic culture, separated by wide intervals of time. Thousands of these Breck implements are beautiful objects, partly owing to their delicate chipping, but chiefly in consequence of their varied and often brilliantly lustrous patination. Among several hundred such implements in my own possession there are very many which, as a result of very long exposure to atmospheric changes, have undergone a superficial change from dull black to a brilliantly lustrous mottled pale or deep blue. The majority of these patinated pieces show human work of only one period, but a considerable number of them have been re-worked at one or more periods long subsequent to that of their original shaping, while in some instances workmanship of three periods can be easily distinguished.

* Proc. Geol. Assoc., Vol. XIX., pt. 2, pp. 76 *et seq.*

† Trans. Norfolk and Norwich Nat. Soc., Vol. VIII., pp. 215 *et seq.*

‡ Delivered at Ipswich on Jan. 13, 1909.

§ January, 1908.

In addition to this, in some of the Breck localities, notable for their abundance of Neoliths, and where it is no difficult matter to find as many as five hundred implements and worked flakes in a single day, no one can carefully examine, say, a hundred pieces without being convinced that they represent three, if not four, widely separated periods. Some are dull, more or less harsh to the touch, and might be mistaken for modern fabrications; others are patinated and lustrous; yet others have undergone a change from black to white; while not a few pieces, in addition to being lustrous and showing patination of more than one period, have their facet ridges or *arêtes* battered and crushed in such a way as to suggest that at some time they have been subjected to considerable pressure and rough treatment.

These last-mentioned implements, the battering of which bears no resemblance to that of the edges of stone tools which have been damaged by use, can generally be included among the scratched or striated Neoliths to which Dr. Sturge has drawn attention, for in addition to being battered they are usually covered with more or less deep scratches. In connection with these scratched implements—which will undoubtedly be fully dealt with by Dr. Sturge in his forthcoming paper—I will only refer to my experience of them in East Suffolk, where I have found a good many of them since Dr. Sturge drew my attention to them about two years ago. So far as this district is concerned, the scratches are on lustrous implements which have generally been made of very hard flint. In some instances they can be felt with the finger-nail as little grooves running for an inch or more along the surface of the implements; but occasionally specimens are met with on which the scratches have become filled in and covered by a lustrous glaze, possibly due to some molecular change in the surface of the flint. As a result of spending a good deal of time in searching for these scratched flints, I can generally tell, before I pick up an implement, whether it will prove to be a scratched one or not; for so far as my experience in East Suffolk goes lustre and scratches usually go together. This is not necessarily the case in other districts, where different patinations occur, and I believe that Dr. Sturge has detected the scratches on implements which have hardly any lustre or patina. The fact remains, however, that in East Suffolk fields where Neoliths of various ages are plentiful, the scratches are found only on the hardest of flint implements, most of which are rather rudely shaped. This proves that the scratches have not been caused by ploughing or harrowing operations. Besides, as Dr. Sturge has pointed out, scratched Neoliths abound on certain lands in the Breck district which have never been subjected to agricultural operations. Mr. W. G. Clarke has already recorded in "KNOWLEDGE" the results of certain experiments made in order to scratch the surface of fine chalcedonic flint, these results being all in favour of Dr. Sturge's contention that only glacial action can explain the presence of striæ on Neolithic flints.

It will soon be generally admitted, I think, that the evidence of patination and re-chipping alone is enough to prove that in Britain the Neolithic Age began thousands of years earlier than is generally supposed, while in the event of Dr. Sturge's theory finding acceptance an approximate date for its commencement will be found in times much more remote. When we also consider that distinguished geologists are coming to the conclusion that even our Palæolithic river gravels—which until lately were believed to be post-glacial—originated under glacial conditions, it seems that the solved problems of the Stone Age are simple compared with those which remain to be solved.

Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Reversal, &c. Mr. G. A. Perley (*Journal of Physical Chemistry*, XIII., 630) has recently published the results of some experiments on this subject, carried out at the Cornell University under the direction of Professor Bancroft. Only Seed and Cramer lantern plates were used so that the inferences may not be applicable without modification to plates of other kinds. He supposes that exposure followed by development first gives a normal negative, if prolonged it gives reversal, or a positive, and, if still further prolonged, a re-reversal or second negative, this last, however, being the final product and of the nature of a printed-out result. He finds that a preliminary bath of hypobromous acid or potassium permanganate does not facilitate reversal, as oxidizers have long been supposed to do, but tends rather to reduce it, giving a negative with the same exposure that would give a positive without the bath. [May not this be due to a diminution of sensitiveness caused by the oxidizer?—C. J.] It does tend to give a cleaner, that is, a less foggy plate, and in this sense may be of advantage when reversal is utilised in practical work. The reversal effect is also diminished by slow development—using weak or restrained developers. Abney found that reversal was prevented by bathing the plate before exposure in a five per cent. solution of sodium nitrite. Lüppo-Cramer confirmed this observation and extended it to sulphites. But the author finds that a preliminary bath of sodium nitrite does not prevent reversal, and that when it appears to do so the result is due to too long an exposure with the rapid reduction to metallic silver [presumably a printing-out effect]. The author also tried sensitising the plate by a preliminary bath in a weak developer, but the sensitising and developing effects appear to me [C. J.] to be confused. He comes to the conclusion that reversal produced by thiocarbamide, as suggested by Waterhouse, cannot be due to a "screening" process, but can only be explained by supposing that the unexposed silver bromide is developed more readily by a developer containing thiocarbamide than the exposed silver bromide. An unexposed plate treated with the mixed developer gave "the same brownish violet fog" characteristic of the reversed image produced when the developer containing thiocarbamide is applied to a plate after an exposure of ordinary length. Carey Lea's reversals with dilute and non-reversals with concentrated solutions of sodium hypophosphite the author traces to the action of this reagent as both a solvent and a reducer of silver bromide, and he concludes that its action is not comparable with that of light.

The Resolving Power of Plates. Resolving power is the power to show two adjacent points or parallel lines distinctly as two, and resolution ceases when for any reason the images of the two points or lines merge into each other and appear as one. A series of evenly spaced parallel lines, that is a grating, if not resolved appears as an even and uniform surface. It is obvious that photographic plates in which the sensitive substance is granular must of themselves set a limit to resolution. The general idea was that the finer the grain the greater the resolving power; but this Dr. Mees, in a paper communicated to the Royal Society, has shown is only partially true. The particles of silver salt in a photographic plate are white or yellow, and a considerable portion of the light that falls upon them is reflected and therefore partly scattered sideways, causing a spreading of the image. Dr. Mees finds that the

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as observed telescopically on January 22, 1910, at 5h. 30m.

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spreading is not due to reflection only, but also to diffraction. The resolving power of plates increases as the size of the grain diminishes down to a certain point, and then grows less as the grain is further reduced. Or in other words, the image of a line which is thickened by scattered light in a coarse grained plate becomes less thickened as the size of the grain is reduced, but on further reduction it becomes more thickened by diffraction, and on reducing the grain still further the thickening diminishes again until it practically vanishes in films, as prepared for Lippmann's interference colour photographs. A chlorobromide plate with particles of ·0008 mm. diameter gave a very much more diffused image than plates with particles either twice or half that diameter. Those, therefore, who seek for fine images—that is, good definition, as, for example, in photomicrography and in spectroscopy—must take care that they do not go too far in the direction of fineness of grain, unless indeed they go a great deal farther, or they may be worse off than if they used an ordinary rapid coarse grained plate. The paper, with its illustrations and measurements, is reprinted in the *British Journal of Photography* for the 24th of December last.

The Fifth International Congress. Taking advantage of the fact that a Universal Exhibition is to be held in Brussels during the coming summer, it has been arranged that the Fifth International Congress of Photography shall be held in the same place early in August. It is hoped that this country will be well represented, and to facilitate matters a preliminary circular in English has been prepared, a copy of which will be sent to anyone who expresses a wish for it on a postcard addressed to Mr. Chapman Jones, 11, Eaton Rise, Ealing, London, W. The special aim of these congresses is to secure a useful measure of uniformity throughout the world with regard to those photographic matters in which diversity is an unmitigated disadvantage, and to give opportunities for the interchange of opinions on subjects of common interest. They are held at irregular intervals as may be convenient and as the various subjects dealt with appear ripe for discussion. The Congress meets to do its work, but at the same time social functions and the pleasures of entertainment are not altogether neglected.

Lenses, &c. The interesting specimens illustrating the making of modern photographic lenses that Messrs. Dallmeyer showed at the Shepherd's Bush Exhibitions held during the last two years are now permanently on view in the Science Museum at South Kensington. Messrs. Dallmeyer announce that they have improved the "Adon," their small telephotographic lens, making the mount lighter and smaller, and at the same time dispensing with the loose ring that was necessary when used, as it often is used, alone. Though originally designed for attachment to the ordinary lens, the "Adon" is complete in itself and gives excellent results on practically any scale.

CHINESE PERENNIAL WILD RICE.—A plant closely resembling the wild rice of North America was collected about seventy years ago in the Trans-Baikal region of Siberia by a Russian botanist Turczaninow. At that time the American wild rice was known to European botanists under the name *Hydropyrum esculentum*, and Turczaninow's plant, being regarded as congeneric with it, was named *Hydropyrum latifolium*. When Hackel monographed the grasses for Engler and Prantl, he decided that the Asiatic plant was only a variety of the American species, and, resurrecting the Linnæan name, *Zizania aquatica*, applied it to both. Mr. C. S. Scofield says that certain significant characters indicate that the Asiatic plant is a distinct species from the American. The American plant is an annual, being reproduced by seed which falls off into the water as soon as ripe. The Asiatic plant is perennial, capable of reproduction by rhizomes. There are also some differences in the floral characters, these being most apparent in the form of the floral pedicel and in the length of the awns of the glumes.

CORRESPONDENCE.

Bombay Duck.

SIRS,—I am entirely at a loss to understand why your correspondent, Mr. Edward J. Buck, should assume that the fish known in the dried form in India as Bombay Duck is a Leptocephalus, especially as he is acquainted with Day's description and classification of this fish. I thought that the illustrations to my paper would have made clear what was meant by a Leptocephalus, even if my description in the text of my article had failed to do so. It is true that there is a slight superficial resemblance between the Indian fish, whose scientific name is *Harpodon nehereus* and a Leptocephalus—the Harpodon is elongated and compressed in shape, and partially transparent, but there the resemblance stops, and in structural characters the Harpodon has no resemblance to Leptocephalus or to the adult eel. One of the chief characters of the fishes of the eel group, which gives rise to the name Apodes, is the absence of the pelvic fins; in Harpodon these fins are large and long. In Leptocephalus there is no separate tail fin, but dorsal and ventral fins continuous round the caudal end; in Harpodon there is a short dorsal fin, a short ventral fin, and a distinct caudal fin with a curious projection of the body through the middle of it; there is also a small adipose fin behind the first dorsal, as in the salmon. In Harpodon there are also scales on the posterior half of the body, in Leptocephalus there are none. Finally, Harpodon is adult, Leptocephalus is a larva.

All ichthyologists so far as I know are agreed in placing Harpodon, as Day did, among the Scopelidæ, a family represented by the well-known phosphorescent Scopelus. At first sight Harpodon seems to have the characters of a deep-sea or abyssal fish, although it is found chiefly in rivers and estuaries; but the resemblance is probably more apparent than real, for deep-sea fishes are usually deep black in colour, not transparent, and Harpodon has small eyes, while deep-sea forms usually have large eyes. The chief resemblance is due to the very large mouth and formidable dentition of Harpodon, which are merely related to predaceous habits, as illustrated by Mr. Buck's observation, and not necessarily to abyssal life.

Yours, etc.,
J. T. CUNNINGHAM.

Astrology.

SIRS,—As you have admitted two attacks upon astrology to the December number of your valuable magazine, will you permit me a few lines by way of comment. It is only too evident that the authors of the attacks in question have never made a practical study of astrology. The objections they advance have been replied to over and over again; but the replies are most likely unknown to your readers unless they are acquainted with the published writings of astrologers. I have been an amateur astronomer for many years. Four years ago I was led to a practical examination of astrology and to the reluctant conclusion that there is something—and a great deal—in it. If you, Sirs, are prepared to devote a portion of your space to the matter it will not be difficult to furnish satisfactory replies to the objections you have published; but I will content myself here with observing that if any of your readers want to know the truth of the matter they will find immense interest in studying the subject at first hand and testing its truth for themselves. In natal astrology I have done so over and over again, and am positive that an immense body of truth lies behind it. At Cardiff we have lately founded an Astrological Society on what I believe to be original lines, for in our Society astrologers and opponents of astrology meet on equal terms, put forward their facts, and state their views with candour and frankness. As De Morgan said long ago, "if astrology be true it is a useful truth," and we are foolish to neglect it. I believe that in a generation or two the truth of astrology will once again be admitted, and it is already winning its way steadily back to recognition.

Yours, etc.,
Tremynfa, Llanishen, Cardiff. ARTHUR MEE.

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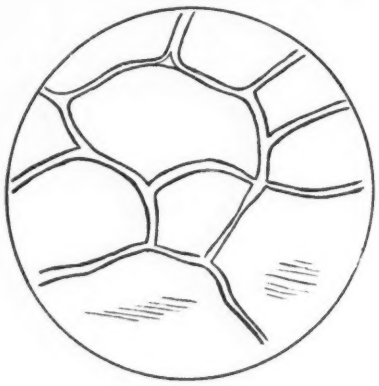
Martian Canals.

SIRS,—I have for a long time thought that it was very possible that the so-called canals of Mars might be explained by the theory that they were brought about by natural geological agencies. Cracks brought about by shrinkage might give the deceptive appearance of canals. On the other hand, after the hardening of Mars' crust, it would no doubt be broken up repeatedly by volcanic action from below, and if the cracks then formed were filled in, as many of our dykes are, they would present in certain lights an appearance as of canals. I send with this a sketch of the surface of a tin of hardened vaseline. Ridges ran across it, as will be seen, like a network of canals, and these



varied according to the strength and direction of the light which fell upon it. The ridges had been formed by the welling-up of some part of it, which still remained soft, after the main mass had cooled enough to offer an obstacle, as a crust, to the rise of the soft portion below. Such a thing would be very likely to have happened during the cooling of Mars, and light as it was reflected on both sides of the ridge, sometimes more, sometimes less, would give rise to the occasional absence or presence of some of the banks of the so-styled canals.

Yours, etc.,
E. A. MARTIN.

"Astronomical Superstitions."

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—I am glad to see by your editorial note appended to "Correspondence," in the January number of "KNOWLEDGE," that you will not allow the intolerant attitude of the Rev. Jos. W. Brady to influence the character of your journal.

It seems curious that Mr. Brady should not appreciate the objections which would accrue, in a *purely scientific journal*, by its intervening in any form, even in footnotes, in theological explanations or definitions. Further, on what grounds does Mr. Brady write in the name of "your readers"? There are some, at any rate, who are desirous of knowing, and not afraid to read in an article, the opinions of others, although they may not hold the same. How could a scientific journal that would not insert extracts because some theological opinion was traversed in them be satisfactory to scientific inquirers? Mr. Brady should have recourse to a theological magazine which inserts edited "scientific notes."

Yours, etc.,
C. B. HUNTER.
Lt.-Col., late Ind. Med. Ser.

Sharcot House, Near Pewsey,
January 6, 1910.

SIRS,—I have read the unwarrantable attacks made upon your recent article, "Astronomical Superstitions," and as one of your many readers I would like to show appreciation of your broadness in printing same. I am sure such an exhibition of bigotry will not deter you from publishing articles because they may not meet with the approval of this sect or that caste, otherwise you would be unable to openly discuss the most recent archæological discovery lest you should hurt the feelings of some Hindu or Brahmin reader; for are they not to be equally considered as any "Rev." gentleman. Besides, the scoff at sixpenny rationalistic publications is gratuitous. I have read many of these and, indeed, they are almost invariably the works of world-wide scientists and philosophers, at a price which places them within the reach of a class who otherwise would never be able to afford them, and perhaps be driven to spend their sixpences in trashy novels instead.

Yours, etc.,
W. OPPENHEIM.

"Hillside," St. Helen's,
January 16, 1910.

SIRS,—When, in the current number of "KNOWLEDGE," the Rev. J. W. Brady says that certain "exploded scientific theories of creation" referred to in the article, "Astronomical Superstitions," were never dogmas of the Roman Church, he overlooks the fact that on March 5, 1616, the Holy Congregation of the Index delivered the following Decree:

> "And whereas it hath also come to the knowledge of the said Holy Congregation that the false Pythagorean doctrine of the mobility of the earth and the immobility of the sun, entirely opposed to Holy writ, which is taught by Nicolas Copernicus, is now published abroad and received by many—
>
> "In order that this opinion may not further spread to the damage of Catholic truth, it is ordered that this and all other books teaching the like doctrine be suspended, and by this Decree they are all respectively suspended, forbidden, and condemned."

Yours, etc.,
I. LIGHTON.

32, Warwick Park, Tunbridge Wells,
January 17, 1910.

The Great New Comet.

ON the afternoons of January 21 and 22, 1910, the western skies were quite clear, so that a satisfactory view was obtained of the Great New Comet.

The comet was discernible in the W.S.W. soon after sunset, and as the light of day grew feeble the tail appeared to become more extended. To the unaided vision the length of the tail was estimated to be about four and a half degrees. Its absolute visible length, however, was dependent upon the depth of tone of the surrounding background, and had the sky been quite dark the dimensions referred to would have been considerably increased.

As observed telescopically, the nebulous, though bright, head presented a moderately sized disc, which was appreciably elongated horizontally. From it issued two bright curved wings, both of which constituted the main support of the tail. The comet, as a whole, was decidedly yellow, but such a colour was undoubtedly rendered more pronounced by reason of the low altitude of the object.

An idea of the general telescopic appearance of the comet may be gleaned from the drawing appearing as a Plate Supplement, which was obtained on January 22, 1910, at 5 hours 30 minutes.

SCRIVEN BOLTON.

Headingley, Leeds.

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NOTES.

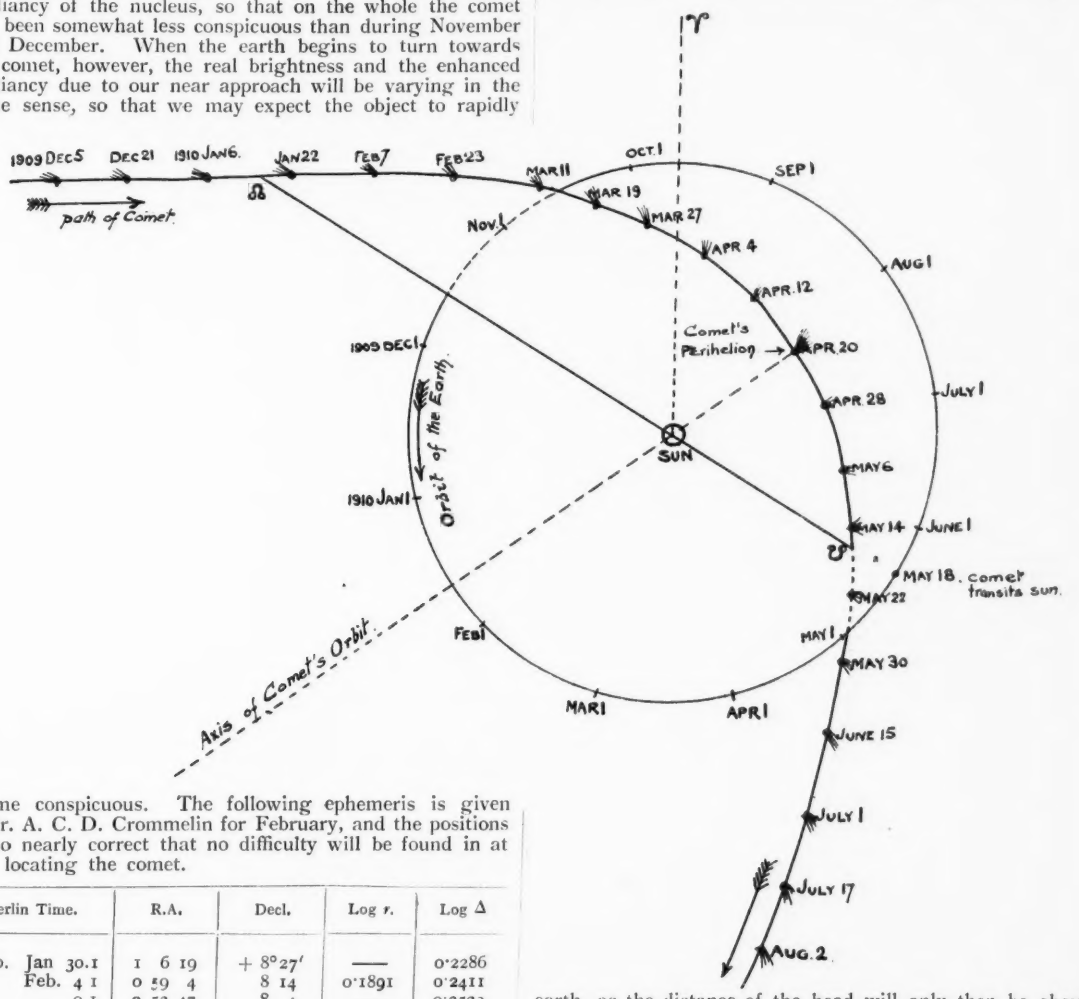
ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S., F.R.A.S.

HALLEY'S COMET.—There is little news to record concerning the progress of this comet during the past month, as it has been gradually receding from the earth; the diminution of brightness on account of increase of distance has not, however, been compensated by the increased intrinsic brilliancy of the nucleus, so that on the whole the comet has been somewhat less conspicuous than during November and December. When the earth begins to turn towards the comet, however, the real brightness and the enhanced brilliancy due to our near approach will be varying in the same sense, so that we may expect the object to rapidly become conspicuous. The following ephemeris is given by Mr. A. C. D. Crommelin for February, and the positions are so nearly correct that no difficulty will be found in at once locating the comet.

Berlin Time.	R.A.	Decl.	Log r.	Log Δ
1910. Jan 30.1	1 6 19	+ 8° 27′	——	0·2286
Feb. 4 1	0 59 4	8 14	0·1891	0·2411
,, 9 1	0 52 47	8 4	——	0·2523
,, 14.1	0 47 18	7 58	0·1445	0·2618
,, 19.1	0 42 36	7 55	——	0·2689
,, 24.1	0 38 2	7 54	0·0939	0·2744
Mar. 1.1	0 33 59	7 55	——	0·2744

During the month it will be seen that the comet travels westwards through the central portion of the constellation Pisces. The apparent slowing of the motion in right ascension is due to the relative motion of the earth and the comet. For the last two months we have been going away from the comet, and this may account largely for the comparative faintness from the conditions in November. The relative positions of the earth and comet are now becoming too intricate to describe from a simple path diagram, and to make it easier for readers to follow things up to the transit in May the accompanying sketch of the relative orbits in space is given instead of another chart. Any question of position near bright stars can be solved by reference to the chart in "KNOWLEDGE" for January, which will cover the path to the end of March. Taking note of the lines joining earth to comet, it is clear that any brightening during February will be due to intrinsic increase of the comet's light, as we are still keeping about the maximum distance away. Shortly after both bodies will bend towards each other in their orbits and then a very rapid increase of the comet in size and brilliancy is to be expected. The position for the comet's transit over the sun on May 18 is indicated; the tail being then directed away from the sun, will in all probability envelop the earth, as the distance of the head will only then be about fifteen million miles.



Observations of the comet's spectrum at Meudon indicate the presence of two bands at $\lambda 388$ and $\lambda 3914.5$, probably agreeing with bands of similar wave-length in the spectrum of Comet Morehouse.

ROTATION PERIOD OF MERCURY.—M. Jarry Desloges, in discussing the series of drawings of Mercury made by MM. G. and V. Fournier at Massegros (altitude 900 metres), finds corroborative evidence of the long rotation period of 88 days. The observations were made during the course of the last eastern elongation in September last, at such intervals that if the rotation period had been 24 hours, some changes in the surface markings should have

been detected. As no such variation was visible, it is concluded that the period must be of much longer duration.—(*Comptes Rendus*, November 29, 1909.)

TOTAL ECLIPSE OF THE SUN, MAY 8, 1910.—This eclipse does not occur under very favourable circumstances for northern observers, and no official expedition is being sent out to Tasmania, the only suitable site on the line of totality. Mr. F. K. McClean, who published some time ago the results of his successful expedition to Flint Island in 1908, intends to organise a private party, and sailed on Saturday, January 15, on board the *Celtic* for New York. In going down the Pacific from San Francisco he will probably call at several of the small islands on the track of the 1911 eclipse, in order to select a suitable site for that event. His instruments are to leave England shortly; these consist of three coronagraphs of different power, and two spectrographs. To feed these with light from the eclipsed sun he is taking a 21-inch siderostat and a 16-inch coelostat. With the siderostat he will use a new Cooke photovisual objective of 6 inches aperture and about 30 feet focal length, giving an image about 3 inches diameter on the slit plate of a Rowland concave grating spectrograph of 10 feet radius of curvature. The first order spectrum will be employed, giving a dispersion of $13\frac{1}{4}$ inches from D to K The same mirror will furnish light to the De La Rue coronagraph, of $4\frac{5}{8}$ inches aperture and 7 feet focal length, loaned by the Solar Physics Observatory.

The 16-inch coelostat will feed a coronagraph consisting of a Cooke photovisual objective 4 inches aperture and 16 feet focal length, loaned by the Solar Physics Observatory. This same instrument was used by Mr. McClean during the eclipse at Palma in 1905. By the side of this coronagraph there will be a small objective grating spectrograph having a Voigtlander objective of 4 inches aperture and about 42 inches focal length, outside which is adjusted a Thorp plane grating replica, 17,000 lines to the inch, set for the first order spectrum. It is hoped that with this it will be possible to obtain useful records of the chromospheric and coronal spectra. The *locale* of the expedition will probably be on the S.E. coast of Tasmania, in the neighbourhood of Ransgate, but the site will probably be selected chiefly with regard to the meteorological prospects. An expedition is also being fitted out by several Australian observers.

CIRCULATION IN SUN-SPOT VAPOURS.—At the last meeting of the Royal Astronomical Society a further paper was communicated by Mr. J. Evershed dealing with the phenomenon characterised as radial motion in sun-spots. Since the former paper numerous other results have been obtained, and the spectrum of every considerable spot photographed during some portion of its path across the solar disc. All of these showed the systematic displacements previously noted, and in addition a slight residual motion has been detected in the nodal positions, indicating that the motion is not strictly radial, but that the spot vapours constituting the penumbra follow spiral paths from the umbra outwards. The vertical motion in the spot vapours is very small, the mean of a considerable number of determinations giving a descending velocity of 0.4 km. per second. This factor is evidently exceedingly difficult to observe, various workers getting different results, some with an ascending residual, others making the average motion one of descent. Evidence obtained during Mr. Evershed's recent work show almost conclusively that the outward radial motion of the vapours is confined to the reversing layer. When the central cores of the wide calcium lines at H_3 and K_3 are examined, it is found that these are twisted in the opposite direction to the lower level lines, suggesting an inward radial motion. On the pressure theory these H_3 and K_3 lines represent the higher and rarer regions of the chromosphere, and we have thus a strong suggestion that there is a definite circulation in typical sun-spots. One of the difficulties in the way of a complete explanation is that the umbræ of spots appear to give no decided evidence of motion, either horizontal or vertical, so that the mechanism whereby the higher chromospheric indraught may be connected with the low-level out-pouring remains still to be investigated.

NEW COMET.—In telegrams from the Kiel Centralstelle it is announced that a comet has been observed at Johannesburg, south-south-west of the sun. It was seen on January 17, at and after sunrise, and was approaching the sun. Its position is recorded as follows:—

1910. January $16^d\ 21^h\ 21{\cdot}5^m$ (Johannesburg Mean Time) R.A. = $19^h\ 50^m\ 28^s$, Decl. = $-\ 25^\circ\ 9'$ S.

Daily motion is about + 16m. 32s. in R.A.; + 20° 25′ in decl. This indicates a position in the north of the constellation Sagittarius, making almost a right angled triangle with the bright stars α Lyra (Vega) and α Scorpii (Antares). During the month this comet has presented a striking appearance in the south-western sky at sunset. Under good conditions it has been seen to have a well developed nucleus, some 51″ diameter, with several envelopes constituting the head on the side towards the sun, and a long double tail sweeping away from the sun to a distance of 10-15°. At Mount Hamilton Dr. W. H. Wright has observed the spectrum of the head to be continuous, with indications of bright sodium lines. The comet is travelling rapidly to the north-east, and should be looked for in the constellation Pegasus.

BOTANY.

By G. MASSEE.

ON THE NATURE OF ALGAL, OR BOGHEAD, COAL.—Renault and Bertrand, the French and Belgian paleobotanists, after studying the dull bituminous coals and schists, arrived at the conclusion that certain organisms present were the remains of oil-containing colonial gelatinous green algæ. It was assumed that the preservation of these delicate organisms was due to the presence of bitumen in the matrix in which they were fossilised. The origin of this bituminous matter has been the subject of much speculation; having been attributed to the putrefaction of animals; to the decay of the algal matter, and to the precipitation of dark-brown humus-saturated bog water. Dr. E. C. Jeffrey has given an account in *Rhodora* of recent investigations on this subject, and has demonstrated that the supposed algæ of Renault and Bertrand are in reality the larger spores, or macrospores, of Vascular Cryptogams, which flourished during the coal periods. The imagined algæ are in fact only the spores in the strongly sculptured coats of the spores in question. The apparent organisation of the algæ as colonies forming a hollow sphere is explained as the highly sculptured wall of the macrospore surrounding its empty cavity. The macrosporic nature of these remains is apparently placed beyond doubt by the occurrence of the triradiate ridge on the face originally in contact with the three sister macrospores, and by the characteristic structure of the spore-wall, as shown in thin sections. It seems highly probable, as the result of these observations, that the bituminous matter found in Boghead and similar coals, as well as in oil-shales, etc., is in reality a product of the modification of the natural waxy or cutinoid infiltration of the outer coats of innumerable spores (microspores as well as macrospores), than the product of animal or algal decay. The author concludes as follows:—"The results here indicated seem further to overthrow the sapropelic or gelosic hypothesis of the formation of certain coals and of petroleum proposed in Europe and to a certain extent adopted in this country."

A detailed account is given of the methods followed in the preparation of coal, which enabled very thin sections to be cut and afterwards bleached.

A PHILIPPINE SUBSTITUTE FOR LIGNUM VITÆ.—Lignum vitæ (*Guajacum officinale*, L.) is one of the most valuable woods in the world, obtained principally from the West Indies. During recent years, however, heavy and indiscriminate cutting has so depleted the forests of this tree, that manufacturers are seriously engaged in discovering a substitute. Mr. Hutchinson gives an account in *Bull.* No. 9, *Phil. Bureau of Forestry*, of the occurrence of many excellent hard woods in the Philippine Islands, one of which, Mancono (*Xanthostemon verdugonianus*, Naves), he considers to possess the qualities necessary to allow of its use in place of Lignum vitæ. The heart-wood of Mancono is brownish, turning purple when exposed to

the air; the sapwood is very narrow. The wood is very heavy and hard, having a specific gravity, after drying for fifty-nine hours at a temperature of 105-110° C., of 1.236, equal to a weight of 77 pounds per cubic foot. The grain is fine and twisted, and the fibres rather short and exceedingly thick-walled. The hardness of the wood is mainly due to the thick-walled fibres, but partly also to deposits in the vessels. Lignum vitæ is a trifle heavier than Mancono, although the latter is harder, and the West Indian wood has much the finer grain, and is therefore more difficult to split, hence Mancono is evidently inferior to Lignum vitæ in some respects, yet it has enough good qualities to indicate that it may be profitably utilised as a substitute. The wood is highly prized by the Filippinos on account of its durability and freedom from the attack of white ants.

NOTES ON HYDNORA AFRICANA, THUNB.—The genus *Hydnora* is confined to Africa, Bourbon, and Madagascar. All the species are parasites living on the roots of different trees and shrubs. Mr. R. Marloth has given some account of *H. africana* in *Trans. S. Afr. Phil. Soc.* This species is parasitic upon the common milk-bush of the Karroo and Karroid regions of the interior, viz., *Euphorbia mauritanica*, L. The plant consists of an underground angular stem covered with tubercles, but produces no roots, attaching itself to the root of the host by means of suckers. At these spots the Euphorbia root swells considerably, and as the free end usually dies, such a root does not feed its own plant any more, but serves merely as a feeding tube for the parasite, through which the building materials which it requires are drawn from the host.

A peculiar structure of the flower, not previously observed, consists in the presence of a large snow-white body attached to the inner side of each perianth segment of the flower in the bud stage. These white masses contain fat and albuminous matter, while every other portion of the plant is highly impregnated with tannin. These white bodies emit on decaying a smell of putrefaction and attract a species of beetle called *Darnicstes vulpinus*, which effects pollination during its sojourn in the interior of the flower, which from its peculiar structure is really a trap for these beetles, which allows them to enter, but prevents their escape until the flower shrivels. During their imprisonment the beetles become dusted with pollen, when they enter another flower, thus effecting cross-pollination. These observations explain why the white bodies have not been previously described. The flowers examined by botanists have had the white bodies eaten out by insects, or had decayed during the drying of the juicy plant.

The fruit contains a jelly-like mass, in which the minute seeds are imbedded, and the author considers that such fruits are unearthed and eaten by porcupines, which during their nightly wanderings disseminate the plant afterwards. The fruit is also said to be a favourite food of the jackals, hence the colonial name, "jackal's kost."

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

DECOLORISING ACTION OF CHARCOAL.—The well-known power of animal charcoal of removing coloured impurities from sugar and other organic compounds was attributed by Dr. Knecht to the presence of nitrogen in the charcoal, while Messrs. Glassner and Suida concluded that the active decolorising agents were compounds containing cyanogen groups. An investigation of the same subject has been made by MM. Pelet and Mazzoli, who have determined the composition and decolorising capacity of a large number of commercial decolorising charcoals, and have arrived at quite different conclusions. They find that the price of these charcoals is not proportional to their decolorising power, and that mineral impurities such as calcium carbonate, calcium phosphate, and iron oxide do not play any part in the decolorising process. Absorption experiments with solutions of methylene blue and crystal scarlet have shown that successive treatment of animal charcoals with acids and alkali to eliminate nitrogenous compounds does not materially affect their decolorising action, and the conclusion drawn from the results is that the absorptive capacity of decolorising charcoal cannot be attributed to the presence of nitrogen or of chemically-active nitrogenou groups.

ALCOHOL FROM SAWDUST.—In 1900, Dr. Classen, of Aachen, took out patents all over the world for a process of heating sawdust and other forms of cellulose in a closed vessel at a temperature of 120° to 145° C., with a solution of sulphurous and sulphuric acids. The sugars formed in the reaction were extracted from the mass with hot water, and the solutions after being neutralised were fermented and distilled in the usual way. So successful were the results on a large scale that a manufacturing plant to carry out the process was erected in Missouri, and it was claimed that this was capable of producing from 18 to 20 gallons of absolute alcohol from a ton of wood waste. It was soon found, however, that the manufacture could not be made commercially profitable, owing to the length of time required for the hydrolysis of the sawdust, the difficulty of extracting the sugars, and the rupturing of the lead lining of the converter, which had to be repaired after every two or three operations. Hence, after running for a year, the plant, upon the construction and working of which some £60,000 had been spent, was allowed to stand idle.

In 1904 Messrs. Ewen and Tomlinson made experiments to overcome these drawbacks of the Classen process, and succeeded in reducing the time for the hydrolysis from six hours to about 40 minutes, and in devising a form of converter less liable to be attacked by the acids. An experimental plant to test the working of this modified process was set up last year on high ground some miles from Chicago. With the aid of this apparatus about 20½ gallons of absolute alcohol can be obtained from dry sawdust, or a little over 14 gallons from wet sawdust. Containing over 70 per cent. of water when rectified, this spirit is drinkable, and has no odour or flavour of the wood. It is perfectly colourless and quite free from methyl alcohol and higher alcohols. It is claimed that in this way industrial alcohol will be produced at a cost of less than a half of that of alcohol obtained by the ordinary process. The material left in the converter consists of cellulose, which on further treatment with steam and sulphur dioxide yields only a trace of sugar. A process of a similar kind is being worked in France. This, too, is stated to be a modification of the Classen process, and to have the advantage over the American method of yielding not only 20 gallons of alcohol per ton of sawdust, but also of producing valuable by-products such as acetic acid. Those who are interested in the development of this industry, which appears to promise the much-desired cheap industrial alcohol for motor engines, varnishes, etc., will find many further particulars in a communication by Professor Ruttan to the "Journal of the Society of Chemical Industry."

"AMORPHOUS" SILICON.—According to Dr. Wilke-Dorfürt, a bluish-grey form of silicon may be prepared by fusing together sodium silicofluoride, sodium and aluminium, and extracting the fused mass with acids. When this product is treated with hydrofluoric acid, it yields a brown powder, also consisting of silicon, but much more reactive than the other substance. Thus when it comes in contact with strong nitric acid flame is emitted, and the acid is decomposed with the liberation of oxides of nitrogen. It appears to consist of crystals in a fine state of division, and, in fact, it is suggested that the different capacities for reaction of these products are to be attributed to differences in the fineness of the state of division, and that it is unnecessary to assume that they consist of distinct modifications of silicon. Thus the relatively inert bluish-grey form is intermediate between the more active brown form and ordinary crystalline silicon both as regards its colour and behaviour with reagents.

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

GNEISSES AND ALTERED DACITES OF VICTORIA.—On January 12, a paper on "The Gneisses and Altered Dacites of the Dandenong District (Victoria) and their Relations

to the Dacites and to the Granodiorites of the Area," was read by Prof. Ernest Willington Skeats, D.Sc., at a meeting of the Geological Society.

The area described lies about 25 miles south-south-east of Melbourne. The early geological surveyors regarded the dacites as palæozoic "traps" passing gradually into the granodiorites. Prof. J. W. Gregory first described the rocks as dacites, probably of Lower Tertiary age, resting upon the denuded surface of granodiorites and of the adjoining Lower Palæozoic sediments. The author described the field-relations of the rocks, and showed that gneiss occurs between the dacite and the granodiorite in places. Elsewhere at the contact the dacite appears slightly altered. The contact with the plutonic rock is everywhere abrupt. No foliation or banding occurs in the granodiorites, but acid veins pass from the junction into the altered dacite and also cut across the foliations of the gneiss. The field-evidence, therefore, shows that the dacites are older than the granodiorites, and also that the gneiss was formed before the intrusion of the acid veins.

The dacite was first erupted, and, following shortly on that, the granodiorite (of slightly more acid composition) was intruded into the dacite. Certain changes are attributed to contact-metamorphism caused by the intrusion of the granodiorite.

CROYDON BOURNE FLOWS.—Some little interest has been shown in the London newspapers on the possibility of an outbreak this winter of the intermittent Bourne which last flowed in the winter of 1903-4, from the Caterham Valley into the Croydon Valley. The period of its flow is very irregular, and has always been so. Taking its rise in the chalk hills, the water supply which it might afford is a question of great economic interest. Mr. Baldwin-Latham's paper (*Proceedings* Croydon Nat. Hist. Soc., 1904) is the best and most inclusive that has been written on the subject. From 1876 to 1883 inclusive there was a yearly flow of the Bourne, after which it flowed every second year until 1897, when there was no further flow until 1903-4. The last year quoted was a remarkable one for similar Bourne flows, others being recorded from Hants, Herts, Kent, Oxfordshire, Surrey, Sussex, and Wilts. "Bourne flows," Mr. Latham states, "are due to the large amount of rain that falls in the higher portions of the district, raising the level of the ground water which flows down the valleys in a wave-like form." It is nothing more than a flood in the underground water passing down from the higher to the lower portions of the district, swelling out of its ordinary underground channels over the surface by reason of the general elevation of the underground water line. It is interesting to note that since 1877, Mr. Latham has accurately predicted both the volume and date of all subsequent Bourne flows, and no doubt it will be made public should the evidence go to show that another flow is imminent. To geologists, the existence of this Bourne is interesting as a reminiscence of the time when this and other dry valleys gave a constant flow of water, and we can readily judge that given a greater rain-gathering area for the chalk downs, and a greater height than now, the precipitation would have been sufficient to give a constant flow. Another intermittent stream which formerly flowed from Merstham to Red Lion Green at Smitham Bottom, whenever the Croydon Bourne flowed, at one time formed a permanent tributary to it, and together they fed the still existing Wandle.

PICTURES OF COAL-MEASURE FLORA.—Geologists who do not know a little book called "Fossil Plants," by E. A. Newell Arber, M.A., F.G.S., will, I think, be glad to have their attention drawn to it. It is published in Gowan's "Nature Series," and at a cost of 6d. one can obtain fifty first-class photographs of fossils illustrating the flora of the Coal-Measures. The pictures are really excellent, and I know of no work at anything like the price where so much value is obtainable. There is a short but adequate description of each illustration, and these include representatives of the *Lycopodiales*, *Filicales*, *Equisetales*, *Sphenophyllales*, and *Cordaitales*. The characteristic markings of fronds and leaves seem to stand out in bold relief, and to a young collector the little book is invaluable.

ECHINOIDS FROM CALIFORNIA.—We have received "Notes on Echinoids from the Tertiary of California," by R. W. Pack, from the University of California. Descriptions and illustrations are given of *Scutella fairbankei*, *Scutaster andersoni*, *Scutella* (?) *norrisi*, and *Spatangus* (?) *pachecoenis*.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.Met.Soc.

THE RAINFALL OF 1909.—Dr. H. R. Mill has given in "Symons's Meteorological Magazine" and also in *The Times* (January 14) a preliminary survey of the rainfall of 1909 over the British Isles, based on the returns from about 2,000 stations and the comparison of 100 long-established records with their own averages. He shows that in southern England nearly two-thirds of the stations had rainfall above the average, in Wales three-quarters of the stations had a rainfall below the average, and in northern England 18 stations out of 22 had more than the average, In Scotland the stations quoted are practically half below and half above the average, and in Ireland the great majority are below. The following summary of percentages shows considerable local differences in the general rainfall of the various divisions :—

England S.	Wales.	England N.	Scotland.	Ireland.	British Isles.
102	95	107	99	95	100

There is nothing more misleading than the grouping of statistics in arbitrary divisions, but when the percentage figures are placed in their proper positions on a map and defined by lines drawn according to their magnitude there is a certain symmetry in their variations, an orderly arrangement which points to, if it does not clearly reveal, the cause of one part of the country being wetter and another part of the country drier in a particular year than the normal. The map of differences from the average is particularly interesting on this occasion. There are two conspicuous dry areas in which the rainfall was more than 10 per cent. below the average. One was in the extreme south-west of Ireland, Wales, and England, where for the last five years the annual rainfall has always been deficient, and where in 1909 the deficiency culminated with more than 20 per cent. below the average of Cork Harbour and the Isles of Scilly. The other was in the north-west of Scotland. The distinctly wet regions where the rainfall was more than 10 per cent. above the average surrounded the south and east of Great Britain, one area lying along the south and south-east of England, culminating in a patch round the Thames estuary, where the excess was more than 20 per cent. of the average. The second area with more than 10 per cent. of rain was in Lincoln, the east and north of Yorkshire and Lancashire, and there were also four very small patches with an equal excess respectively near Newcastle, the margin of the Moray Firth, in Galloway, and in the west of Donegal. The extreme dryness of the north-west of Scotland and the wetness of the south-east of England in the month of June was certainly brought about by a northern anti-cyclone clearing the sky for sunshine on the north-west coast, while a procession of small cyclones passing up the Channel brought gloom and showers to the south-east. This suggests the controlling influence of unusual pressure distribution in disturbing the normal relation between configuration and rainfall brought about by the winds due to the average distribution of pressure, and it is interesting to note how particular stretches of country seem to be sheltered from or subjected to excessive rain by the temporary distribution of pressure for several consecutive years at a time, and then other tracts are treated in the same way.

The rainfall of the individual months always shows greater variations than that of the whole year, and the following table of percentages shows how the main divisions of the country were affected.

1909.	England & Wales.	Scotland.	Ireland.	British Isles.
	%	%	%	%
January	53	117	90	77
February	40	62	64	50
March	182	112	130	153
April	112	152	187	138
May	77	118	89	90
June	141	69	79	110
July	127	119	100	119
August	95	66	47	78
September	90	56	78	79
October	139	151	140	142
November	35	61	56	46
December	166	105	119	141
Year	103	99	95	100

The wettest month for the British Isles was March; and in that month great stretches of the south and east coasts had more than twice their average rainfall; but the same month was the driest of the year in the extreme west of Scotland. This character of exaggerated extremes applies also to June, and was passed on by March and June to the year, the March and June rain mainly being responsible for the dryness of the north-west and the marked excesses in the south and east, though these were also helped by the great falls in the south and east of England in October. November was unquestionably the driest month of the year, for the average was hardly reached at any point, and over the whole of England the rainfall was only one-third of the normal.

ROYAL METEOROLOGICAL SOCIETY.—The Annual General Meeting of this Society was held on January 19. The Council in their Report stated that they had forwarded a memorial to the Royal Commission, which is now enquiring into the work of the University of London, urging that the time is fully ripe for placing the study of Meteorology on a more satisfactory basis and for its inclusion among the subjects for Degree Examinations. The Council have arranged for a Provincial Meeting to be held at Manchester on February 23, and they hope that this will be the means of making the work of the Society better known in a district in which considerable attention is already being given to Meteorology.

The President presented to Dr. W. N. Shaw, F.R.S., the Symons Gold Medal for 1910, which had been awarded to him by the Council in consideration of his distinguished work in connection with Meteorological Science.

Mr. H. Mellish, in his Presidential Address, referred to some relations of Meteorology with Agriculture. The close dependence of agriculture upon climate and upon the periodical variations of the weather has been recognised from the earliest times, but the relations are of such a complicated character, and the difficulty of separating the effects of the different factors is so considerable, that as much progress as might have been expected has perhaps not been made in applying the data of meteorology to the purposes of agriculture. The President first referred to the writings of various authors on the subject of temperature and rainfall as affecting the wheat and other crops, and then proceeded to deal with such questions as the liability of some crops and especially of fruit, to injury from frosts; the influence exercised by forests upon climate and especially upon rainfall; and the study of phenology. He next considered what steps meteorologists could take to further the application of the data of their science to the various problems of agriculture. It is doubtful whether farmers make as much use of the forecasts and weather reports as they might. Possibly this may arise because they are not familiar with the technical terms in which the reports are necessarily couched. This might be remedied in the course of time if instruction on the subject could be worked into the courses at the agricultural schools and colleges. The Royal Meteorological Society has lost no opportunity of urging the importance of the subject to farmers, and also the inclusion of meteorology under the head of Nature study in the schools, and there are reasons to think that this is having some effect. Mr. Mellish, in conclusion, said that from the opportunities which their life throws in their way, farmers should make the best of observers, and if they once become familiar with the teaching of the science and its importance to their affairs, we may hope to derive considerable advantages from their co-operation.

THE ELECTRICITY OF RAIN AND SNOW.—Dr. George C. Simpson, of the Indian Meteorological Office, read a paper on this subject at the Royal Society on January 13. In connection with a theory of the electricity of thunderstorms published in a former paper in the "Philosophical Transactions," measurements of the charges of rain were made in Simla in 1908, and it appeared advisable that these should be continued for a second year.

The data obtained during the second year agreed in all essentials with those obtained during the first, and by combining the results for the two years the following conclusions were arrived at: (1) The electricity brought down by the rain was sometimes positive and sometimes negative. (2) The total quantity of positive electricity brought down by the rain was 3.2 times greater than the total quantity of negative electricity. (3) The period during which positively charged rain fell was 2.5 times longer than the period during which negatively charged rain fell. (4) Treating charged rain as equivalent to a vertical current of electricity, the current densities were generally smaller than 4×10^{-15} amperes per sq. cm.; but on a few occasions greater current densities, both positive and negative, were recorded. (5) Negative currents occurred less frequently than positive currents, and the greater the current density the greater the preponderance of the positive currents. (6) The charge carried by the rain was generally less than 6 electrostatic units per c.c. of water, but larger charges were occasionally recorded, and in one exceptional storm (May 13 1908), the negative charge exceeded 19 electrostatic units per c.c. (7) As stated in (3) above, positive electricity was recorded more frequently than negative, but the excess was the less marked the higher the charge on the rain. (8) With all rates of rainfall positively charged rain occurred more frequently than negatively charged rain, and the relative frequency of positively charged rain increased rapidly with increased rate of rainfall. With rainfall of less than about 1 mm. in two minutes positively charged rain occurred twice as often as negatively charged rain, while with greater intensities it occurred fourteen times as often. (9) When the rain was falling at a less rate than about .6 mm. in two minutes the charge per c.c. of water decreased as the intensity of the rain increased. (10) With rainfall of greater intensity than about .6 mm. in two minutes the positive charge carried per c.c. of water was independent of the rate of rainfall; while the negative charge carried decreased as the rate of rainfall increased. (11) During periods of rainfall the potential gradient was more often negative than positive, but there were no clear indications of a relationship between the sign of the charge on the rain and the sign of the potential gradient. (12) The data do not suggest that negative electricity occurs more frequently during any particular period of a storm than during any other.

During the winter of 1908-9 measurements were also made in Simla on the electrification of snow, and the following conclusions have been drawn: (1) More positive than negative electricity is brought down by snow in the proportion of about 3.6 to 1. (2) Positively charged snow falls more often than negatively charged. (3) The vertical electric currents during snowstorms are on the average larger than during rainfall. (4) The charge per unit mass of precipitation is larger during snowfall than during rainfall.

ORNITHOLOGY.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

OUR SUMMER MIGRANTS.—The attention of the readers of this column is drawn to the Fourth Report of the Migration Committee of the British Ornithologists' Club, which is drawn up on the lines of the earlier reports.

XUM

Those who are interested in the problems of migration —and who is not?—should make a point of securing these reports as they appear, for therein a mass of most valuable information is being slowly garnered that will prove of the highest importance in regard to the periodic movements of our native birds; and more especially so now that we are beginning to realise the fact that many of our resident species, which are partly migratory, like the thrush and robin, can readily be distinguished from the continental races thereof. More correctly, of course, our British-bred birds are to be regarded as "races" of the continental types.

THE DISPLAY OF THE KAGU.—The subject of display in birds has by no means received the attention it deserves, and with the breeding season looming before us it would be well if those of my readers who have the good fortune to be able to pass much of their time in the country during this critical period would endeavour to add to the sum of our knowledge under this head. Mr. Arthur Denman, in the *Avicultural Magazine* for January, gives a most interesting photograph of a Kagu in display, taken in the Gardens of the Zoological Society. We draw special attention to this because the pose assumed is quite different to that usually adopted during moments of exaltation. For instead of the upright carriage, erected crest, and mincing gait, the bird stoops forward and spreads out the wings much after the fashion adopted by the sun-bittern (*Eurypyga*), thereby displaying to the full brightly-coloured markings on the primaries, otherwise concealed.

SHORT-TOED LARK IN SUSSEX.—Mr. Herbert Langton, in *British Birds* for January, reports the fact that a female Short-Toed Lark (*Alauda brachydactyla*) was caught on the Downs, north of Brighton, on November 16, 1909.

ROSE-COLOURED STARLING IN NORTHAMPTONSHIRE.—In *British Birds* for January, Mr. W. C. Cattel writes to say that a Rose-Coloured Starling was shot near Thrapston so far back as July, 1908.

BLACK-WINGED PRATINCOLE IN YORKSHIRE.—A photograph of the Black-Winged Pratincole (*Glareola melanoptera*) accompanied by a long description appears in the January issue of *British Birds*. The specimen was shot near Northallerton, Yorkshire, August 17, 1909. This species gained a place in the British list when, during May and June, 1903, three specimens were shot in Kent.

HONEY BUZZARD IN NORFOLK.—According to the *Zoologist* for January, a Honey Buzzard—sex not mentioned—was killed at Haddiscoe, about 7½ miles from Great Yarmouth, in the second week in October, 1909. The prevailing colour of this bird was of a light umber brown.

LATE NESTING OF THE CROSSBILL IN NORFOLK.—Mr. Heatley Noble, a few days ago, sent to the British Museum of Natural History a female and two nestling Crossbills, which had been taken by a workman from a nest in a fir tree, about 20 feet from the ground, growing near the railway line near Thetford. The man saw the old bird feeding the young and threw a stone at her, killing the old bird and one nestling. The young birds were fully fledged, but still retained a few down feathers on the crown and rump. This record it need hardly be said, is one of exceptional interest.

PHYSICS.

By PROFESSOR A. W. PORTER, B.Sc.

REFRACTIVITIES OF GASES.—Mr. and Mrs. C. Cuthbertson are continuing their researches on the refractivities of gases They find that in air, oxygen, nitrogen, and hydrogen, Cauchy's two-term formula of dispersion is not adequate. This formula may be written $\mu - 1 = a(1 + b/\lambda^2)$ and it is found that b increases in all the above cases as we pass from red to violet.

The dispersion can in all cases be expressed much better by a formula of the form used by Sellmeier and others, $\mu - 1 = C/(n_0^2 - n^2)$, where C is a constant, n is the frequency of the light referred to, and n_0 is the frequency of the free period of those electrons to which dispersion is due.

The following are the values of C and n_0, which are obtained from the experimental results:—

	C.	n_0.
Air	$4{\cdot}6463 \times 10^{27}$ ..	16125×10^{27}
Oxygen	$3{\cdot}397$,, ..	12804 ,,
Nitrogen	$5{\cdot}0345$,, ..	17095 ,,
Hydrogen	$1{\cdot}692$,, ..	12409 ,,
Phosphorus (vapour)	$7{\cdot}61$,, ..	6534 ,,
Sulphur ,,	$4{\cdot}808$,, ..	4600 ,,
Mercury ,,	$7{\cdot}82$,, ..	4360 ,,
	$8{\cdot}37$,, ..	4740 ,,

One of the most interesting results derived from these experiments is the very large values for the free-frequencies, n_0. They correspond, indeed, to frequencies of the same (or even greater) order as Schumann rays. These results are in accordance with the fact that these gases do not exhibit any serious absorption in the ultra violet until the neighbourhood of these very high-frequency rays is reached.

NEGATIVE DISCHARGES OVER PHOTOGRAPHIC PLATES.—To explain the palm-leaf-shaped figures which form when an electric discharge is passed from a negative terminal over a sensitive plate backed by a positive disc terminal, attention has been called to the paths taken by different portions of a firework ball after it has burst. These also diverge like the separate leaflets of a palm-leaf, the motion of each part being the resultant of the translatory motion which the ball has immediately before bursting with the radial velocity generated by the explosion. It is suggested that each one of the fine lines in the figure on the photographic plate represents the path of a simple group of ions, or possibly of a single ion, these several groups repelling one another immediately after their formation.

ZOOLOGY.

By R. LYDEKKER.

AN OVIPAROUS VIPER.—Up to the end of 1909 all the members of the viper tribe were believed to produce their young alive; that is to say, the eggs are hatched within the body of the female parent, so that, strictly speaking, these reptiles should be described as ovo-viviparous rather than viviparous. In the *Field* of January 1, 1910, there appeared, however, a letter from Mr. C. Leigh, written from Kurseong, in which it is stated that the Himalayan pit-viper (*Lachesis monticola*) is oviparous. This viper, which ranges from the Eastern Himalaya to the Malay countries, is remarkable for the great thickness of its body as compared with the length; for while it usually attains a length of not more than about 2½ feet, its girth is sufficient for that of an average 5-foot snake. The ground-colour of the back is ashy grey, upon which is a series of more or less regular dark blotches, with a sprinkling of black and traces of yellow. On the under-parts the general colour is likewise ashy, but with dark red mottlings. In some examples the dark markings on the upper surface are so pronounced that the reptile is scarcely distinguishable from the freshly-turned black soil of the tea-gardens in which it is so frequently found.

It was while working in one of these gardens at Kurseong, during the summer of 1909, that a coolie came across a cluster of snake's eggs. On reaching out his hoe to investigate and pushing the grass aside, a viper of this species made an angry snap at him, but was eventually secured and preserved. Other specimens of the eggs discovered during the same season served to show that the oviparous habit is constant in this viper.

THE EAST AFRICAN OTOCYON.—Copies of a paper by Mr. G. S. Miller, of the U.S. National Museum, published in the "Smithsonian Miscellaneous Collections," Vol. LII., pp. 485-487, and entitled a new carnivori from British East Africa, have recently been received in this country, in which

is described a so-called new species of large-eared fox, under the name of *Otocyon virgatus*. The typical *Otocyon megalotis* was long regarded as an exclusively South African animal, but has for some years past been known to be represented in East Africa, where it ranges as far north as Somaliland. From specimens sent to Washington by the expedition under the leadership of Mr. Roosevelt, it now appears that the East African large-eared fox differs from the typical Cape animal by the under-parts being of a rich buff colour instead of whitish, and also by the presence of a dark stripe along the upper surface of the tail. There are likewise slight differences in the form of certain parts of the skull and of the fourth lower molar. In my opinion, these differences are not, however, of more than racial value, and the animal should be known as *Otocyon megalotis virgatus*.

The amusing part of the matter is that a special Reuter telegram appeared in the English papers of January 11, announcing the discovery of "a new animal," which is stated to differ from the Cape form by being generally "buff in colour." As a matter of fact, the newly described race, for it is in no sense a "new animal," is no more worth mention in the daily press than are the descriptions of new races and species of mammals which appear month by month in scientific journals; many of the latter being indeed of far greater interest. The real interest of the occurrence of *Otocyon* in East Africa is that it serves to connect the typical Cape animal with the extinct Indian *O. curvipalatus*, which is apparently the ancestral form of the genus, and thus constitutes one more link in the chain of evidence in favour of a former land-bridge between East Africa and India.

PAPERS READ.—At the meeting of the Zoological Society held on December 14, 1909, Dr. F. D. Welch communicated notes on a colour-change in an Indian ratel, and on three specimens of the Javan race of the tiger; Dr. W. E. Agar supplied an account of the nesting-habits of a tree-frog of the genus *Phyllomedusa;* the Misses Harrison and Poole discussed madrepores from the eastern seas; Mr. Beddard discoursed on various snakes and monkeys; and Mr. G. A. Boulenger recorded certain observations on the African snakes of the genus *Grayia*. The following papers were down for reading at the meeting of the same Society on January 18, viz., a report by Dr. Plimmer on pathological observations made on the animals during the past year; an account by Mr. S. A. Neave of North Rhodesian butterflies; observations on the marine fishes and invertebrates of St. Helena by Mr. J. T. Cunningham; notes on the hydroid polyps and nudibranch molluscs of Bermuda by Mr. M. W. Smallwood, and descriptions of new or rare crustaceans in the Copenhagen Museum by Dr. W. T. Calman.

REVIEWS OF BOOKS.

CHEMISTRY.

Introduction to the Preparation of Organic Compounds, by Emil Fischer. Translated from the German by R. V. Stanford, B.Sc., Ph.D. (Williams and Norgate; pp. xix. and 175; 4s. net).—This is the seventh edition of Professor Fischer's well-known little introduction to practical organic chemistry. It has been considerably enlarged and now gives directions for the preparation of some 90 typical organic substances, and in particular of the sugars and their derivatives—the group of chemical compounds with which the name of Fischer will always be associated. The book is well translated and clearly illustrated with diagrams of apparatus where required, and could be used as a practical guide by the student working alone, the more so since the precautions to be taken against possible accidents are fully described.

The Romance of Modern Chemistry, by J. C. Philip, D.Sc., Ph.D. (Seeley and Co.; pp. 348; 5s.).—This book belongs to the series issued by the publishers under the name of the "Library of Romance," and is, as its name suggests, of a popular character. It amply fulfils the two requirements of a book of this type of being simply written and in such a way as to hold the interest of the reader who knows little of the subject, while at the same time being scientifically accurate. The scope of the book is very wide, since it deals with subjects so remote as the chemistry of the stars and the behaviour of substances at temperatures below zero. Clear outlines are also given of the chemistry of plant life and of agriculture, and of the applications of the science to everyday life. There might, advantageously, have been fuller treatment, however, of some of the subjects, such as the adulteration of food, while a section on the chemistry of animal life, and on toxines, anti-toxines, and immunity would have added to the value of the book. Doubtless these additions will be made in a future edition. It remains to be said that the book is well printed, and fully illustrated with pictures and diagrams. It should prove a most acceptable present to any boy of a scientific bent, or in fact to anyone interested in a general way in applied chemistry.

MATHEMATICS.

Smithsonian Mathematical Tables, Hyperbolic Functions. Prepared by G. F. Becker and C. C. van Orstrand (Washington: Smithsonian Institution, 1909; pp. 321).—This very valuable and much needed collection includes five-place tables of the hyperbolic functions and their logarithms, seven-place exponentials, five-place natural logarithms, gudermanian of u to seven places, anti-gudermanian to hundredths of a minute, and a table for the conversion of radians into angular measure and vice versa. These tables are very clearly printed. Use alone will, of course, test their accuracy, but they have been very thoroughly checked.

METEOROLOGY.

Weather Indicator, compiled and arranged by William Ballance (London: George Philip and Son, Ltd., 32, Fleet Street; in sheet, 2s. 6d.; mounted on cloth, varnished, with rollers, 3s. 6d.).—This indicator, which is clearly printed on a sheet 41 ins. by 31 ins., is intended to be a guide to the systematic study of weather phenomena. Lists of common signs for inferring the coming weather are set out in tabular form. The classification of clouds, and facts concerning wind, atmospheric phenomena, etc., are given in a concise form. A prominent feature of the indicator is a large-sized "composite weather dial." The effect of this diagram is marred by the arrow indicating true north and south being placed diagonally across the dial, instead of being perpendicular to it, so it is not easy at first sight to understand what it represents. The compiler has given much useful information in a concise form, but his wind figures are not derived from the most recent investigations on the subject. He has also attempted too much in giving the rate of rise or fall of the barometer for certain kinds of weather in *thousandths* of an inch per hour.

MICROSCOPY.

Practical Microscopy, by F. Shillington Scales, M.A., B.C. (Cantab.). Second edition (London: Ballière, Tindall, and Cox, 1909; pp. 334; 122 illustrations; cloth; 5s. net).—The chief merits of this book lie in its instructions in the manipulation of the microscope and its accessories, in the taking of photomicrographs and in the preparation and mounting of microscopic objects. These three branches of microscopy occupy the second half of the volume, and in all three the author will be found a safe guide. In such matters as illumination, drawing, or micrometry, Mr. Scales follows the best practice of the day; while his treatment of such processes as staining or section cutting is a revelation of an enthusiastic worker's experience and should prove to be the book's greatest attraction. With regard to the other half of the book, the reviewer finds it necessary to find excuses for the author. How is it possible for the beginner to make a judicious selection of microscopes or objectives when he is bewildered by a host of these, all of which have some recommendation or other? And yet, if the principles of construction, upon which the author rightly lays stress, are to guide the intending purchaser in his selection, not one-half of the instruments described would be eligible. That is one of the difficulties which beset writers of books on the microscope; the personal judgment is subordinated to the desire to be catholic. A good index is appended. Nominally, this is a second edition; but being

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largely re-written it has the faults of a first edition. There are some misprints. One expects *Farrant's* for *Farrants'*; but the printing of *diffraction* for *refraction*, and similar mistakes, making havoc of the sense, show that the proofs have received but a hurried correction. It takes two nowadays to write a book on microscopy; a little assistance, and this one could have been made the best of its size.

W. B. S.

Outlines of Bacteriology, by David Ellis, Ph.D., D.Sc., etc. (London: Longmans, Green, and Co., 1909; demy 8vo; pp. xii. and 262; 134 illustrations in text; 7s. 6d. net).—A book of this sort brings home to us the wide ramifications into everyday life of the laboratory science of bacteriology. We are accustomed in our daily newspaper reading to frequent allusions to the pathogenic bacteria, and to the work that has revolutionised the science of medicine, but we are apt to overlook the not less important part played by bacteria (advantageous as well as disadvantageous), in connection with our vegetable food, our drinking water, the keeping properties of our food, and the actual growth of plants, to the industrial applications of fermentative processes in connection with the manufacture of alcoholic beverages, butter, cheese, the tanning of leather, the retting of flax and hemp, the changes that take place in tobacco, indigo, tea, and cocoa, and last, but not least essential to our well-being, the modern processes of dealing with sewage. The book under review, though intended as an introduction to bacteriology in all its branches, differs from most books of the kind in paying particular attention to technical and agricultural bacteriology, in which much progress has been made of recent years. Morphology, physiology, and classification are treated as adequately as is necessary in a book of this description, and if the details of cultivation and examination are somewhat brief, they are eminently practical. Methods of microscopical examination are wisely not touched upon, but some useful pages are devoted to the antiseptic and disinfecting powers of certain well-known reagents, including a useful table of proportionate efficiencies. A brief summary is given of the better-known pathogenic bacteria, from the point of view of the general student of science rather than of the medical student, but the book deals more particularly (as already intimated) with the bacteria of the air, of water, and of sewage, with the bacteria of the soil and of plants, and with those concerned in many economic processes. The book is, as its name indicates, only intended as an outline, but is written in a clear and readable style which will make it acceptable not only to the student but to others who desire to learn something of the bacteriology of to-day. The spelling of scientific names is very careless in places, notably in the names of textile fibres.

F. S. S.

ZOOLOGY.

Beasts and Men; being Carl Hagenbeck's Experiences for Half a Century among Wild Animals. An abridged translation, by H. S. R. Elliot and A. G. Thacker, with an Introduction by P. C. Mitchell (London: Longmans, Green, and Co., 1909; pp. xiii. and 299, illustrated; 12s. 6d. net).—When we saw the original German edition of this volume a year ago, we had no hesitation in saying that a translation ought to be offered to the English public, and we are delighted to find that Messrs. Longman endorse our opinion. The book is, indeed, teeming with interest from start to finish, as indeed those who are acquainted with the genial personality of its author would expect to find it; and no better New Year's gift could be selected for either young or old, whether they be naturalists or not, than this delightful and, as Mr. Chalmers Mitchell calls it, remarkable volume. In his introduction Dr. Mitchell states that he believes the translation to be a very accurate rendering of the German text; and it seems to us that its main fault is that it is a trifle too accurate in places for the purpose of good English, while the translators have added certain inelegant and ungrammatical expressions for which the author is probably not responsible. Mr. Hagenbeck is an excellent example of German thoroughness and method in business matters. At the time he entered it, the trade in wild animals was very largely in British hands, but he has succeeded to a great extent in making it a monopoly of his own. In addition to business-like methods of going to work, the trade demands great personal courage and boldness in financial matters; both of which attributes Mr. Hagenbeck has shown himself to possess in a marked degree. So successful, in fact, did he become early in his career, that he practically flooded the market, whereupon he turned his attention to taming and exhibiting animals, thus giving rise to the world-famed animal park at Stellingen. Perhaps his greatest *coup* was the capture of the wild horses of the Gobi desert, thereby proving once for all that such animals really exist. The book should prove of great value to all who have charge of zoological gardens, as it contains the results of a long experience in taming, feeding, and curing animals, with many important hints on the value of open-air treatment. It is also of very considerable interest to naturalists, while it cannot but appeal strongly to the general reader. Unfortunately, limitations of space prevent quotation of any of the author's racy anecdotes, and we must therefore be content with advising our readers to get the book for themselves.

MISCELLANEOUS.

Science in Modern Life, Vols. II. and III.: Geology (cont.), Chemistry, Physics, General Biology, and Botany (London: The Gresham Publishing Co.).—In the second and third volumes of this encyclopædic survey of scientific knowledge, which is being edited by Mr. Ainsworth Davis with the assistance of some of the most accomplished expositors of scientific subjects, Mr. O. T. Jones concludes his summary of geological climates, and deals with the evolution of existing land and sea areas; Mr. J. P. Millington deals with Chemistry; Mr. J. H. Shaxby with Physics; Dr. H. J. Fleure with General Biology; and Mr. J. H. F. Drummond begins his review of botanical knowledge by an essay on its ecological aspects. The purpose which was set out in the first of these volumes, and which by showing the progress and history of a science as well as its inter-relations with other sciences exhibits its importance to mankind, is admirably maintained in those which have succeeded it. Thus, the Geological section aptly concludes with the bearing of geological and geographical conditions upon the human race. Mr. Millington's treatise (for it is no less) on Chemistry begins by outlining the history of chemical conceptions; but the larger part of it is devoted to the "chemistry of life," and to the bearing of chemistry on industry. Chemistry is not a subject on which most authorities find it easy to write at once intelligibly and intelligently, but Mr. Millington's account of the modern views of catalytic action and osmosis, his review of the work being done by Fischer and others on the synthesis of organic matters, is remarkably clear and interesting. Mr. Shaxby's "Physics" is no less remarkable in its lucid interpretations of modern theories of matter and electricity; and his survey of modern electrical methods and some modern speculations is a model of compression. Dr. Fleure's general biology ably summarises the present stage of knowledge with regard to the structure, matter, and mechanism of the cell; and analyses carefully the relative importance of experimental biology from Hertwig to Loeb. The relation of biology to daily life is ingeniously exhibited by observations on the struggle of mankind against parasitic diseases. The Botanical section is to be continued in Vol. IV.; for the present, comment on the arrangement of its sections, which reveal the importance of exact knowledge of plant distribution, is alone necessary. The work as a whole is valuable not only for the excellence of its parts, but for its co-ordination, which aims at showing both the development of knowledge and its relation to the evolution of the planet.

The Book of Nature Study, Vol. V., edited by J. Bretland Farmer, M.A., D.Sc., F.R.S. (Caxton Publishing Co.; 7s. 6d. net).—This volume fully maintains the high standard of excellence, characteristic of the two preceding volumes, dealing with plant life. The first portion of the book is devoted to xerophytic vegetation, and gives a very clear and interesting account of the gradual building-up of a flora on a mud-flat or salt-marsh. Aquatic vegetation, the vegetation of meadows and pastures, and the weeds of cultivation are dealt with on similar lines; the student being continually led to observe the various means by which certain plant communities are enabled to establish themselves, also the factors that determine the gradual disappearance of

such communities. The school garden is treated in much detail from every standpoint, and should prove to be of great value, not only to those concerned with teaching, but to every one interested in gardening. More than six pages are devoted to the cultivation of the apple alone, and cover such subjects as planting, grafting, pruning, etc. This portion of the book concludes with a chapter on "Insect and Fungoid Enemies." The "fungoid" enemies prove to be real fungi, and not something resembling them. The author, in dealing with the summer fruit of the fungus causing potato disease (*Phytophthora infestans*), states that it produces "conidia containing spores," and has also disinterred the myth relating to the presence of resting-spores, which remain dormant during the winter and resume growth in the following summer. The final portion of the book deals with "The work of the Soil," and is in every sense a concise and excellent account of "The Origin of Soils," "The Properties of Soils," "The Characteristics of Different Soils," and "The Principles of Cultivation." Four coloured plates, seventeen black and white plates, and numerous woodcuts aid very materially in elucidating the salient points dealt with in the volume.

Fertilisers and Manures, by A. D. Hall, M.A., F.R.S. (Murray; pp. xvi. and 384; 5s. net).—In this country scientific investigation of the soil and its cultivation still lags far behind what is being done in other countries. In America, for instance, almost every State has its own Experimental Agricultural station, whereas here such research is largely left to private enterprise. It is to this cause, and to the notorious reluctance of the farmer to adopt "new-fangled ideas," that we must attribute the slow development of intensive farming in England. Fortunately, this state of things is gradually disappearing. The work that has been done by agricultural chemists at Rothampsted and elsewhere has given practical proofs of what can be effected by scientific treatment of the soil, and farmers are now much more ready to adopt new methods if it can be shown that it will pay in their case. There could be no better guide for anyone wishing to acquire such knowledge than Mr. Hall, who is well known as the Director of the Rothampsted Experimental Station. In this book, which may be regarded as a companion to the author's work on soils, the nature of fertilisers, their mode of action, and methods of use with special crops and soils, are discussed scientifically, and yet so clearly and simply that anyone without previous chemical knowledge can readily follow the argument. The work will thus be found of the greatest help not only by the farmer but by everyone who wishes to obtain the full benefit of the fertilising materials he applies to his garden. There are numerous photographic illustrations of laboratory experiments, and diagrams of modern apparatus for the distribution of manures, and the book concludes with a very full index.

Ant Communities and how they are Governed; a Study in Natural Civics, by H. C. McCook (New York and London: Harper Bros., 1909; pp. xvii. and 321, illustrated; 7s. 6d. net).—It is more than thirty years since the author published his first observations on American ants and their ways; and during the whole of the subsequent period he has devoted himself to the study of the habits of these most wonderful insects. Indeed, a perfect stream of books, scientific papers, and popular articles on the same subject has flowed from his pen in an almost unbroken continuity. He writes therefore as one having authority; and the present volume, which is to a considerable extent a companion to the first part of his "Nature's Craftsmen," should, therefore, be welcomed by a large circle of readers, both scientific and otherwise, as a handy and well-written compendium of his matured opinions on the nature and origin of ant-communities and the mutual relationships of their constituent grades and classes. In his concluding paragraph he sums up by showing that in these communities there is no such thing as private property. "All citizens are equal. . . . All serve, save natural dependants; but all apparently are free to choose the quality, the period, and the amount of service. There is no visible head, no representative class or body within which the control of the Commonwealth is embodied; and yet, by some occult force hitherto unknown to men, all the beneficent effects of government are wrought out with the regularity and precision of an automatic machine." Ants have, indeed, successfully solved the socialist problem; although this does but serve to emphasise the fact that any such solution is impracticable in the case of human communities.

The Foundations of the Origin of Species, by Charles Darwin. Edited by his son, Francis Darwin (Cambridge: The University Press, 1909; 7s. 6d. net).—Students of evolution, and of Darwin's splendid work in particular, will return their grateful thanks to Mr. Francis Darwin for this volume, which contains two hitherto unpublished essays on the Origin of Species. One of these, written in 1844, formed the basis of the celebrated paper read before the Linnean Society in 1858, and the precursor of that epoch-making book, "The Origin of Species." The other has a strange history. This was written during 1842, but was superseded by the essay written two years later, and apparently its very existence was then forgotten, since in later years he refers only to the later essay. Not until 1896 did it again see the light, when, on the death of Mrs. Darwin, the house at Down was vacated. The MS. was then discovered in a cupboard under the stairs which was not used for papers of any value, but rather as an overflow for matter which he did not wish to destroy. This discovery is of no little importance since it clearly shows that Darwin really owes less than he supposed to Malthus's work on Population, for long before reading this, as his note-books show, he had formulated, more or less distinctly, the Theory of Natural Selection. The perusal of Malthus's work probably helped to confirm and crystallise his own cogitations on the problem. Though strongly tempted to dwell upon the many interesting side-lights thrown by the two essays on his later work we forbear, feeling convinced that those who are really interested in the subject of the birth of his world-moving theory will prefer to read the original.

The Place of Animals in Human Thought, by The Countess Evelyn Martinengo Cesaresco (London: T. Fisher Unwin, 1909).—In this delightful volume a wealth of facts has been brought together bearing on the part played by the lower animals in human thought in the development of superstition and of religion, or art and of fiction. Every possible source of information seems to have been tapped; the crude carvings of pre-historic man; the ancient monuments of Egypt and Assyria, of Greece and of Rome; while the literature of all lands, from the remotest times, seems to have been most industriously explored in the search for information. As might be supposed, the author has thus brought together a most fascinating collection of stories, both in prose and verse, concerning wild animals, pets, beasts of burden, animals of the chase, and performing animals; and these are supplemented by a number of exceedingly attractive illustrations, well chosen, and well executed. This is a book, in short, that all who are interested in animals should certainly possess; it is not a book to borrow from the library. W. P. P.

British Mountain Climbs, by George D. Abraham (London: Mills and Boon, 49, Whitcomb Street, W.C.; pp. xvi. and 448, with 18 photographic illustrations; 7s. 6d. net).—This is a handy volume for the pocket, and the illustrations are excellently reproduced. That there is work to be done in Britain in the way of mountain climbing is manifest from the mass of material brought together in this work, even if one had not realised it in one's own experience. We have carefully verified in the book such climbs as we are familiar with, and can cordially recommend it to all who desire to partake in this exhilarating and somewhat dangerous form of enjoyment. Personally, we would not adopt some of the routes chosen; we would prefer easier and less dangerous ways.

Scientific and Technical Books.—Messrs. W. and G. Foyle, of 135 Charing Cross Road, London, W.C., have sent us a copy of their catalogue No. 18, comprising a selection of books on scientific and technical subjects. The books are classified under numerous headings, and in most cases second-hand copies can also be supplied.

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MICROSCOPY.

Conducted by F. SHILLINGTON SCALES, M.A., F.R.M.S.

The Book-Louse and the "Death-Watch."

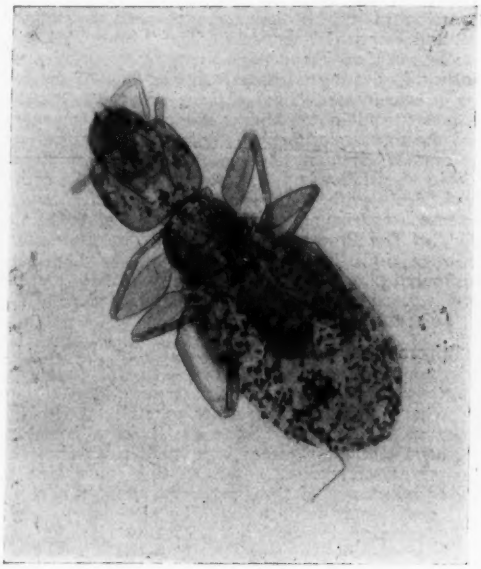
LAST month a beetle injurious to tobacco was described and illustrated in these columns, and since then a correspondent has sent me a photograph of an insect which was taken from the corner of a book, and which, though somewhat imperfect as a photograph, I reproduce here. As stated by my correspondent, the dark spots are evidently due to imperfect clearing.

This photograph is that of the "Book-Louse," *Atropos divinatoria*, Fab., and it is of sufficient interest to deserve an extended description.

Atropos divinatoria is a pale, louse-like insect belonging to the Psocidæ and of the same order as the white ants. It measures less than 1 mm. in length, occurs usually in houses, and may often be seen scampering across the page to find a new place of concealment when a musty old volume is opened. It is an exceedingly small insect, nearly colourless, and almost invisible to the naked eye except when its active movements call attention to it. There are a number of species of psocids which frequent houses, all popularly known as book-lice, and with very similar habits and characteristics to the one just named, which is, however, the commonest and most annoying species, and may be taken as the type. *Atropos divinatoria* has no trace of wings, and represents one of the lowest forms of insect life. A great many species, however, live out of doors, many of these being winged and somewhat resembling plant-lice. They are frequently found on the bark of trees, and on the walls of buildings, and feed on lichens or decaying vegetable matter. The Psocidæ are biting insects, and have well-developed mandibles and other mouth parts.

The most interesting point connected with *Atropos divinatoria* is its reputation for making a curious ticking sound, by which it has gained the name of "death-watch," and the popular superstition is that the sound presages the death of some member of the household where it is heard. That the insect can, by striking its head against some hard object, make some such noise seems to be pretty well established, though the honour of being the actual "death-watch" has been claimed for *Clothilla*, an allied genus of similar habits, but it is difficult to believe that so small and soft an insect can make a sound so distinctly audible. Many entomologists claim that the sound is really made by a beetle of the genus *Anobium*, which lives in wood, and that the beetle being concealed in a hole, and *Atropos* seen running about, the sound is attributed erroneously to the latter. The rapping of *Anobium* is, however, well known, and is stated to be of a different character to that of the "death-watch," and an observer has stated that the sound has been produced in a work-box wherein the Psocid was certainly present, and the most careful search failed to reveal any beetle.

The subject has an historical interest, as more than 200 years ago the Rev. W. Derham, then Rector of Upminster, Essex, and a distinguished writer, contributed two papers to the Royal Society on the ticking of "death-watches." He was a very careful observer, and weil acquainted with the ticking of *Anobium*, and his description of the ticking corresponds with our own knowledge. He said, in the course of one of his papers, "I am now so used to and skilful in the matter as to be able to see, and show them, beating almost when I please, by having a paper with some of them in it conveniently placed and imitating their pulsation, which they will readily answer." He also stated that he could not hear the beating save when it was done on paper,



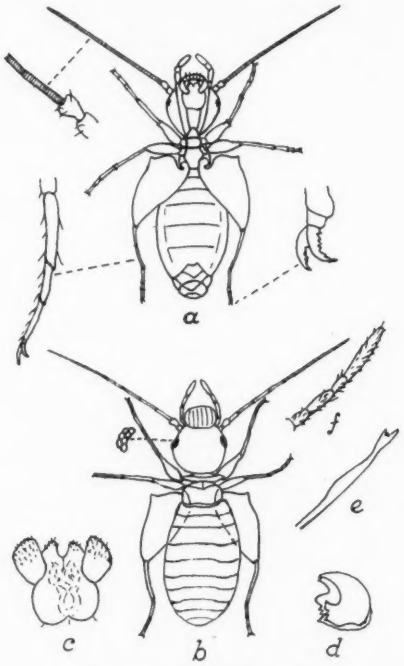


Fig. 1.—Atropos Divinatoria.

a, Adult from below; b, same from above; c, labium; d, mandible; e, maxilla (?); f, maxillary palpus.

and that the ticking would be continued for hours together without stopping, so as to closely resemble the ticking of a watch. The ticking was accompanied by a rapping of the front of the head of the insect upon the paper, but Mr. Derham was not sure whether the actual sound was produced in this way, as each stroke was accompanied by a peculiar shudder or recoil. He noted in particular that after prolonged ticking another insect of different sex made its appearance. The drawings accompanying Mr. Derham's article are stated, however, more to resemble a *Hyperetes* than *Atropos* or *Clothilla*.

The house species are widely distributed, and frequently cause considerable damage and trouble. During the summer they may be found in cupboards, on window ledges, library shelves, and especially amongst books or papers which are seldom disturbed. They feed on nearly any animal or vegetable matter, and are particularly fond of the starchy paste found in book-bindings or under wall-papers. They also feed on flour, meal, &c., and are very destructive to natural history collections. Only in rare instances do they multiply in excessive numbers. Many Psocids are partial to straw mattresses, and have been found in large numbers in straw in barns and stables and in straw coverings for wine bottles.

More than one case has been recorded, however, in which the insects have been extraordinarily numerous. "In a new house, kept by very neat occupants, a mattress of hair and corn husks which had been purchased some six months before was found in September, after the house had been closed about six weeks, to be so covered with these insects that a pin-point could not have been put down without touching one or more of the bugs. The side of the lower sheet next the mattress was likewise covered, and further search showed the walls—and, in fact, the entire house—to be swarming with them. A sweep of the hand over the walls would gather them by thousands; bureau drawers were swarming with them, and they were under every object and in everything. The mattress was found to contain millions of them, and seemed to be the source of supply. The measures taken were most thorough. The mattress was promptly removed; walls and floors were washed with borax and corrosive sublimate solution; carpets were steam-cleaned; pyrethrum was freely used; furniture was beaten, cleaned, and varnished—the struggle being kept up for a year with all the persistence of an extraordinarily neat housekeeper. The insect continued to have the best of it, however, and persisted, though in diminished numbers. The family then removed to an hotel, and for days the house was fumigated with burning sulphur and the scrubbing was repeated. The insect was not entirely exterminated, and the house was vacated again and subjected to the vapour of benzine. The insects, two years after the removal of the mattress, were reported to be still in the house, greatly reduced, but to be found in dark corners."

For the drawings accompanying this note, and for not a little of the information concerning this insect, I am indebted to the Bulletin of the United States Department of Agriculture, No. 4, 1896.

Royal Microscopical Society.

December 15th. E. J. Spitta, Esq., L.R.C.P., &c., Vice-President, in the chair. Attention was called to some enlargements of photo-micrographs of the antennæ and falces of a female spider exhibited by Mr. H. S. Cheavin; to some specimens of the rarer Foraminifera from Selsey Bill, exhibited under a microscope by Mr. E. Heron-Allen; and to some photographs of arranged diatoms, &c., from Mr. M. J. Allan, of Geelong.

The Chairman alluded to the death of Dr. Dallinger, who had been a Fellow of the Society since 1871, and in 1884 and the succeeding three years was President, and the meeting joined in a message of condolence and sympathy with the family. A paper by Mr. A. A. C. E. Merlin on "The Measurement of Grayson's Ten Band Plate" was read to the meeting, in the absence of the author. Dr. Marshall Ewell's paper on "A Convenient Form of Stand for Use as a Micro-Colorimeter and with Micro-Spectroscope" was also read, diagrams in illustration being shown upon the board, and was followed by Dr. James F. Gemmell's paper on "An Automatic Aërating Apparatus for Aquaria," with illustrative drawings on the board.

Mr. F. Enock then gave a lecture on "The Life History of the Hessian Fly, with Notes on the Tenby Wheat Midge," the subject being illustrated by a number of beautifully coloured lantern slides, showing the various stages from the egg to the perfect insect, and the effect of the ravages of the larva upon the affected corn. Although known in America as far back as 1776, and believed to have been introduced there in the straw mattresses of some Hessian troops, it was not until 1886 that public attention was called to it in this country. The fallacies then circulated were described and corrected by Mr. Enock, and the true life-history, as traced by the lecturer, was given. Some notes on observations on the Tenby Wheat Midge, *Clinodiplosis equestris*, followed, and were illustrated by lantern slides, and by the exhibition of a living larva under the microscope.

During the course of the evening the Chairman expressed the hope that when new Fellows joined the Society their friends would introduce them to the Secretaries and other prominent members present, so that they should rapidly become acquainted with them all.

Quekett Microscopical Club.

December 28, 1909.—Mr. R. T. Lewis, F.R.M.S., read a "Note on the Pollination of the Asclepiads." He said that when examining recently some insects from Lindley, Orange River Colony, he noticed, adherent to the feet of one of the Hemiptera and to those of two of the larger Hymenoptera, some small yellow objects. Examination under the microscope showed them to be of vegetable origin, and further investigation proved them to be the dried pollen sacs of some species of Asclepiad. Their adherence was so firm that a knife had to be used to remove them. They were of elongated pear-shape, greenish yellow in colour, and occurred in pairs attached at their narrow ends to a dark-brown base, of more rigid structure, formed of two short processes united at one end, the division between these forming a kind of clip by which they were firmly affixed to the pulvilli or spinous hairs on the feet of the insects. An extract from Kerner and Oliver's "Vegetable Kingdom," Vol. II., pp. 257-9, describing the structure and method of fertilisation of the Asclepiads, was read. "During the time when the honey is most abundant the flowers are either nodding or pendant, and offer no convenient place for the insects to alight upon, or from which they can comfortably suck the honey. In endeavouring to take firm hold, the insect draws its claws from one end of the slit to the other and so becomes attached to the clip-like organ at the back. When the foot is withdrawn the two pollinia adherent to the clip are dragged out of their niches and one of the claws on that foot is then wedged between the arms of the clip whilst the two pollinia are suspended from it. Insects caught after visiting flowers of *Asclepias cornuti*

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have often been found to have from five to eight of these clips fastened to a single foot."

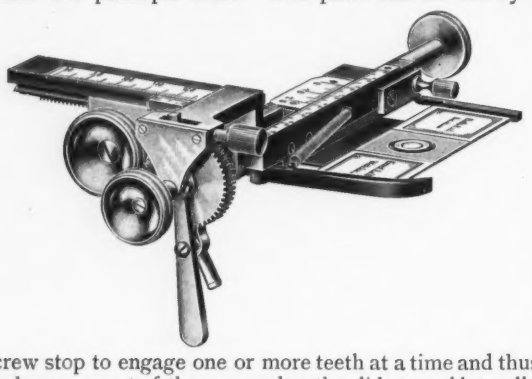
Preparations were exhibited showing, *in situ*, a clip with pollinia still attached fixed to the claw on an insect's leg, and another of a leg showing a clip attached to the claw.

Journal of the Quekett Club.

The November issue of this excellent little Journal (published half-yearly) contains several interesting papers and notes, and a full report of the proceedings of the Club, which have been duly chronicled in these columns. The address of the President, Prof. E. A. Minchin, M.A., &c., is entitled "Some Applications of Microscopy to Modern Science and Practical Knowledge," with especial reference to three recent medical discoveries, the list of which might easily have been extended. Recent advances in surgery and in surgical technique are often acclaimed as if purely medical science had nothing comparable to its credit, whereas the most marvellous discoveries of recent years have been in the domain of medicine. Prof. Minchin laid particular stress on the discovery that malaria was due to a lowly organism introduced into the human blood-stream by the bite of an infected mosquito; that the disease known as "sleeping sickness" is due to a trypanosome transmitted by the tsetse-fly; and that yellow fever is beyond doubt also transmitted to human beings by the bite of a certain species of mosquito, though the parasite itself has not yet been isolated. Mr. W. Wesché contributes some "Notes on the Life-History of the Tachnid Fly, *Phorocera serriventris*, and on the Viviparous Habit of other Diptera," with a plate; and Mr. C. F. Rousselet a paper "On the Geographical Distribution of the Rotifera." Mr. F. P. Smith, the Hon. Editor of the Journal, gives an interesting and useful account of his methods of mounting spider dissections, in which whisky takes the place of the usual alcohol. A paper by Mr. A. C. Banfield is summarised below for the benefit of readers who have not access to the original publication.

Automatic Mechanical Stage.

Messrs. Ernst Leitz have brought out an ingenious removable mechanical stage, which, besides the usual vertical and horizontal movements, has a pawl and ratchet wheel arrangement which moves the horizontal adjustment automatically. A reference to the illustration will make the principle clear. The pawl can be set by a



screw stop to engage one or more teeth at a time and thus each movement of the arm makes the slide travel laterally a definite distance each time in either direction as required, thus greatly facilitating searching or counting. The pawl can also be thrown out of gear in an instant. The whole mechanism works very smoothly and steadily.

A Method of Preparing Stereo-Photo-Micrographs.

Amongst the many photo-micrographers to be found in the ranks of microscopists comparatively few have turned their attention to the interesting and beautiful results which can be obtained by applying stereoscopic methods, with their realistic appearance of depth and contour. From time to time various methods of procedure have been alluded to in these columns, and a paper contributed to the Quekett Club Journal by Mr. A. C. Banfield may be of service to many, though only a condensation is possible here. Each of our two eyes receives a different impression of an object, due to the fact that each eye looks at it from a different point of view because there is separation between the two eyes. A stereoscopic picture requires, therefore, a couple of photographs taken from slightly different positions, and generally the photographer does this by means of two separate cameras, mounted parallel to each other on the same base-board, and about 80 millimetres apart. This is, however, as Mr. Banfield points out, excessive, the average distance between the pupils of the eyes being about 62 mm., and this is the reason why ordinary stereoscopic views on sale in the shops give so distorted and exaggerated a sense of relief. Similarly a couple of stereoscopic views (of fixed objects) can be taken with a single camera, a small sliding board in a grooved guide being readily obtainable at photographic shops to fasten to the tripod and allow of the camera being moved from one end of the slide to the other, a distance of 80 millimetres, to allow the two photographs to be taken in the correct positions.

Mr. Banfield makes use of this last method. He starts with a simple formula. Accepting the average inter-ocular distance as 62 mm., divide this amount into the desired magnification, and the result will be the correct separation of the lenses for that particular magnification. Thus, to photograph an object × 62, the objectives must be separated by 1 mm., if × 31, then the separation must be 2 mm., and so on. This rule holds good with all objectives and all magnifications.

It is, of course, not possible to get objectives so close together as 1 mm., nor alternatively is it possible to move a long and heavy camera, such as is necessary in photo-micrographic work, so small an amount, and it is necessary, therefore, to devise a means of moving the object.

Mr. Banfield's method is simplicity itself. He observes that the formula given resolves itself in practice into two parallel lines drawn on the focussing screen 62 mm. apart, by means of the stage. Plates of the usual stereoscopic size, $6\frac{3}{4}$ ins. × $3\frac{1}{4}$ ins., are used. The object is moved till one of the lines cuts the image centrally, and the first exposure is then made; it is then transferred to the other line, when a second exposure will give a stereoscopic pair of negatives.

The illumination is of importance, and Mr. Banfield, like other workers, finds incident light easier to use than transmitted light. The illuminant he has found most convenient is the Nernst lamp with one ampère filament, but he has found the incandescent gas mantle satisfactory also, though, of course, with longer exposures, especially with high powers. In this connection he draws attention to an easily overlooked point. As each picture must have an identical exposure, a time of day must be chosen when the pressure is steady, and he finds about midday and nine in the evening the most suitable in this respect. With limelight equalised exposures are difficult to obtain, pitting of the lime often giving trouble in the midst of an exposure. The arc light enables one to make short exposures, but requires care in use, or the specimen or lenses may be damaged by the heat.

Mr. Banfield finds autochrome plates unsuitable for stereoscopic work, owing not so much to the length of exposure as to their patchiness. As is well known, in the mixing "a number of grains of the same colour will

persistently adhere to each other, these forming distinct colour blotches, which float in space over the picture proper when seen in the stereoscope." He adds, "as photomicrographic work is usually done with an artificial source of light, the usual autochrome filter is unsuitable. A special filter is made for the electric arc, which I have not used with any great success. It is doubtless correct for a certain composition of the carbons; but these are continually varying, creating small differences in the colour composition of the light, to which these plates are exceedingly sensitive." Finally, he recommends the use of a special blue filter to convert the Nernst lamp to approximate daylight, and then to use the usual daylight filter. This necessitates long exposures, but gives accurate colour rendering.

Notes and Queries.

L. D. C. (*Edmonton*).—To ascertain the magnifications of your objectives and eyepieces it will not do to attempt to superimpose visually the image of the stage micrometer in the plane of the stage, because you are not projecting the visual image in the plane of the stage. People with normal eye-sight generally project the image of objects seen through the microscope tube about ten inches away from the eye, a distance which in a short tube microscope does not correspond with the stage. But even were this so, the measurements would be difficult and misleading. There are two methods which can be followed. The one is to use a Beale's neutral tint reflector, which is merely a disc of glass (smoke-coloured to obviate disturbing double reflections from the surfaces) set above and close to the eyepiece and at an angle of 45 degrees to the optic axis of the microscope, pointing outwards and upwards. The microscope must be placed horizontally and supported at such a distance from the table that the optic axis is ten inches from the table. If, now, a stage micrometer be focussed in the usual way by looking down upon the Beale's reflector the lines will be seen reflected, and can be traced upon a piece of paper lying immediately beneath. Some little adjustment of the brightness of the microscope image and of the brightness of the paper will probably be necessary. The lines upon the paper can then be measured with a rule, and their original value being, of course, known, a measurement of the combined magnification as seen by a normal eye at the usual visual distance of ten inches is obtained. Short-sighted people may need to use spectacles to enable them to see the paper at this distance, but their magnifications in the microscope (unless there is marked myopia) will not differ greatly from the normal, as it is the angle which enters the eye which is the important factor. The combined magnification will, of course, vary if the tube is drawn out, as the objective then forms its image further away in the tube, and so increases the magnification. The magnification of the ocular does not vary. The whole subject, and especially methods of finding out the independent magnifications of objectives and eyepieces, is dealt with fully in several of the more practical hand-books to the microscope.

J. F. (*Chesterfield*).—From your description you have apparently got hold of an old lens of $\frac{1}{32}$ of an inch focus, and as this is probably what is known as a "dry lens" (which means that it is used dry and not with a drop of water or cedar-oil between it and the cover glass of the object), the working distance is so short that it will only focus an object covered by the very thinnest of cover-glasses. Probably the other is also a lens, as it screws into the same fitting, but your description is not clear enough for me to be sure.

G.—You will have no difficulty in getting an achromatic condenser which will fit into a sub-stage ring. The leading makers, such as Beck, Baker, Swift, Watson, etc., make condensers for microscopes thus fitted, and if your instrument is by one of them you have only to write to them on the matter. But if by an unknown, or little known, maker, it will be advisable to send the ring to one of the above makers, and give at the same time the exact thickness of the stage, and the size of the opening in it, if the opening be smaller than the sub-stage ring. It will be understood that the top of the condenser comes through this opening, and when in focus reaches nearly level with the stage, so that there might be some difficulty with a large-topped condenser and a small opening in the stage.

Staining Mosses.—Mr. N. L. Gillespie, of Fulham, is good enough to communicate the following method of staining mosses, such as Sphagnum, to show the spiral and other thickenings of the cell-wall of the leaf. After careful cleaning, the moss is hardened and decolourised in methylated spirit for a week or ten days. The stain used is acid aniline green, made up by dissolving 2.5 grams in 6 oz. of methylated spirit, and it is allowed to act for about five minutes—certainly not more. The specimen is then washed in methylated spirit, cleared in clove oil, and mounted in Canada balsam. Overstaining can be rectified by a few minutes' immersion in spirit. A stock solution can be made of twice this strength, and diluted as required.

Keeping Volvox.—A correspondent at Richmond kindly writes to me in connection with my answer to "C. A. M." on this subject last month: "I have frequently kept Volvox flourishing for quite a fortnight in my garden. I have an old cistern which I keep in a sort of rough aquarium, and in this I am always sure of finding Volvox. This morning it was plentiful. This tank is supplied with rain-water, and I think that is the secret of success. I renew my micro tank-water from this tank—not tap water. Volvox is abundant everywhere now."

Microscope Preparations.—Messrs. Clarke and Page have sent me a list of second-hand microscopes and apparatus, and a supplementary list of new preparations of microcope slides, including insect preparations, mounted, after the method of Mr. Fred Enock, without pressure, which have been previously favourably noticed in these columns. They have sent me a very fine slide of that exquisite polyzoan *Lophopus cristallinus*, mounted in liquid and beautifully clean and transparent, which they justly claim to be much superior to ordinary mounts in Canada balsam. All the slides mounted by this method show the same transparency. Messrs. Clarke and Page state frankly that only the test of time will show if slides prepared by this new method are really permanent, but the attention they have given to the matter justifies them in believing this. A slide of the Alima stage of Squilla shows the structure not less satisfactorily, and amongst the list of insect preparations is one of *Vespa sylvestris*, of which Messrs. Clarke and Page have themselves bred queens for the purpose of mounting.

F. W. H. (*Runcorn*).—Condensers may, generally speaking, be divided into two classes—those which are achromatic and aplanatic, and those which are not. To the latter category belong what are generally known as "Abbé illuminators." They are in common use in laboratories, and are comparatively inexpensive, but for anything approaching to critical work with good objectives, especially high powers, they are much inferior to the achromatic type. Their aperture varies from N.A. 1.2 to N.A. 1.4, but to obtain the whole of this the upper surface of the condenser must be in immersion contact with the under surface of the slide, though this is generally not necessary. Their disadvantages are want of correction, there being much outstanding colour, whilst their aplanatic cone does not amount to half their full aperture. The achromatic condenser is, therefore, much to be preferred, and will make its value felt, especially in photo-micrography. It is made with an aperture of N.A. 1.0 (used dry), or of N.A. 1.4, used as an immersion condenser. The former has generally a magnification of about $\frac{3}{4}$ inch, and the latter of about $\frac{1}{3}$-inch. The former is preferable for all-round work, and is most likely to suit your purpose; the latter is used for critical work with high-powers only. The condenser should be mounted with iris-diaphragm and swing-out ring for stops and coloured glasses. The firm you mention would doubtless be able to supply your requirements.

O. W. (*Winscome*).—There is nothing unusual in the occurrence you mention.

[*Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Redcourt," Adams Road, Cambridge. Correspondents are requested not to send specimens to be named.*]

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The Face of the Sky for February.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 7.42 and sets at 4.46; on the 28th he rises at 6.51 and sets at 5.35. Sunspots may occasionally be observed, though they are not very numerous. The positions of the Sun's axis, centre of disc, and heliographic longitude are given below.

Date.	Axis inclined from N. point.	Centre of Disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Jan. 31 ..	11° 46'W	6° 1'	37° 2'
Feb. 10 ..	15° 41'W	6° 38'	265° 22'
,, 20 ..	19° 4'W	7° 3'	133° 41'
Mar. 2 ..	21° 52'W	7° 14'	1° 58'

Towards the end of the month the Zodiacal Light should be looked for in the West, immediately after sunset.

THE MOON:—

Date.	Phases.	H. M.
Feb. 2 ..	◐ Last Quarter	11 27 a.m.
,, 10 ..	● New Moon	1 13 a.m.
,, 16 ..	◑ First Quarter	6 33 p.m.
,, 24 ..	○ Full Moon	3 36 a.m.
Feb. 12 ..	Perigee	10 0 p.m.
,, 28 ..	Apogee	10 36 p.m.

OCCULTATIONS.—There are no occultations of the brighter stars observable before midnight.

THE PLANETS.—Mercury (Feb. 1, R.A. $20^h\ 1^m$; Dec. S. 17° 1'. Feb. 28, R.A. $21^h\ 6^m$; Dec. S. 17° 44') is invisible during the early part of the month, but towards the end becomes a morning star in Capricorn, rising about 6 a.m. on the 20th. The planet is at greatest westerly elongation of 26° 32' on the 20th.

Venus (Feb. 1, R.A. $21^h\ 55^m$; Dec. S. 5° 49'. Feb. 28, R.A. $21^h\ 3^m$; Dec. S. 8° 41') is in inferior conjunction with the Sun on the 12th and is practically unobservable throughout the month.

Mars (Feb. 1, R.A. $2^h\ 11^m$; Dec. N. 14° 16'. Feb. 28, $3^h\ 15^m$; Dec. N. 19° 19') is visible in the evenings and sets about 12.40 a.m. throughout the month. The planet although diminishing in brightness is with his ruddy colour a fairly conspicuous object, being near the meridian at sunset, but for small telescopes he is now very difficult for any detailed observations of surface markings; the apparent diameter is only 6". The distance of the planet from the earth increases more and more in 1910 and observations become correspondingly difficult; the planet will, however, become a favourable object in 1911.

Jupiter (Feb. 1, R.A. $12^h\ 56^m$; Dec. S. 4° 24'. Feb. 28, R.A. $12^h\ 51^m$; Dec. S. 3° 47') is the most conspicuous object in the late evening sky looking East. The planet is describing a retrograde path in Virgo about 7° N.E. of Spica. The attendant bright moons can be seen in very small telescopes, or even in a pair of binoculars magnifying 6 or 8 times, whilst the belts are also visible in small telescopes of about two inches aperture using a magnifying power of about 50. The equatorial diameter of the planet on the 19th is 41"·5, whilst the polar diameter is 2"·7 smaller; this polar flattening is readily observed in telescopes powerful enough to see the belts.

The following table gives the satellite phenomena visible in this country before midnight.

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
Feb.			
5	III.	Sh. I.	11 45
7	II.	Ec. D.	11 52
8	I.	Sh. I.	11 56
9	II.	Tr. E.	11 18
Feb.			
16	II.	Tr. I.	11 0
	I.	Ec. D.	11 8
	III.	Oc. R.	11 44
	II.	Sh. E.	11 55
17	I.	Sh. E.	10 34
Feb.			
17	I.	Tr. E.	11 25
23	II.	Sh. I.	11 45
24	I.	Sh. I.	10 12
	I.	Tr. I.	10 58
25	I.	Oc. R.	10 26
	II.	Oc. R.	10 31

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse.

Saturn (Feb. 1, R.A. $1^h\ 10^m$; Dec. N. 4° 52'. Feb. 28, R.A. $1^h\ 19^m$; Dec. N. 5° 53') is observable for a few hours after sunset, as he sets about 10 p.m. on the 14th. The planet is a conspicuous object in the South-West portion of the sky, and appears in Pisces a few degrees South-East of the Square of Pegasus. Observed in the telescope, the ring appears open fairly wide since we are looking on the Southern surface at an angle of about 12°. The apparent diameters of the outer major and minor axes of the ring are 39" and 8" respectively, whilst the diameter of the ball is 15"·6. In the telescope, in addition to the ring, the belts on the planet's disc—although not so conspicuous as those on Jupiter—may easily be discerned.

Uranus (Feb. 14, R.A. $19^h\ 40^m$; Dec. S. 21° 56') is a morning star, rising about 6.50 a.m. at the beginning of the month.

Neptune (Feb. 14, R.A. $7^h\ 13^m$; Dec. N. 21° 40') is situated in Gemini, about half a degree South of the star δ Geminorum. The planet is on the meridian about 9.30 p.m. near the middle of the month, and is practically above the horizon the whole night throughout the month. He is difficult to detect except in large telescopes, but he may be identified in small telescopes by his relative motion if successive observations are made some few days apart.

HALLEY'S COMET.—The ephemeris of the comet is given in another column and a chart showing its path among the stars will be found on page 26 of the January issue. Observing about the middle of last month with a 10-inch reflector, I found the comet to be a faint nebulous mass, somewhat elongated and with a slight nucleus. Towards the end of this month it will appear in the evening sky looking South-West, and it may be visible to the naked eye; but judging from its present appearance slight optical assistance will probably be required.

METEOR SHOWERS:—

Date.	Radiant. R.A. h. m.	Radiant. Dec.	Near to	Characteristics.
Feb. 5-10 ..	5 0	+41°	η Aurigæ	Slow; bright.
,, 15 ..	15 44	+11°	α Serpentis	Swift; streaks.
,, 20 ..	12 4	+34°	Cor Caroli	Swift; bright.

Minima of Algol occur on the 14th at 11.25 p.m., and on the 17th at 8.14 p.m.

Double Stars.—*Castor*, separation 5"·6, mags. 2·7, 3·7. Excellent object for small telescopes. The brightest pair to be observed in this country; can always be relied upon as a good show object.

κ Geminorum, separation 6"·3, mags. 4, 8·5; very pretty double.

ξ Cancri, separation 1"·1, 5"·1, mags. 5·5, 6·5, 7·5; with small telescopes the wider component is readily seen.

ν Draconis, separation 61"·7, mags. 4·6, 4·6; a pretty and easy double, can be separated by observing with a pair of opera glasses.